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Murakami

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(54) **FUSER DEVICE AND IMAGE FORMING APPARATUS**

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(73) Assignee: **Oki Data Corporation**, Tokyo (JP)

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(51) **Int. Cl.**
G03G 15/20 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/2053*** (2013.01); *G03G 2215/2025* (2013.01)

(58) **Field of Classification Search**
CPC G03G 2215/2025
See application file for complete search history.

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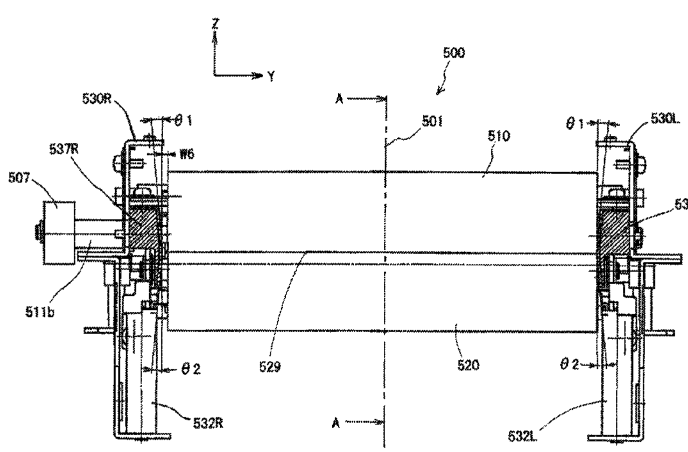
(57) **ABSTRACT**

A fuser device includes a belt part rotating in a tension free state to carry a medium in a medium carrying direction, a first nip forming part arranged inside the belt part, a second nip forming part arranged outside the belt part sandwiching the belt part with the first nip forming part so that a nip area is formed therebetween, and a regulation member regulating a movement of the belt in a width direction of the belt part. The regulation member is configured with a belt regulation part and a slant part. The belt regulation part has a flat shape arranged near one of side edges of the belt part along the nip area with a predetermined gap (W**6**). The slant part extends from an edge of the belt regulation part.

17 Claims, 19 Drawing Sheets



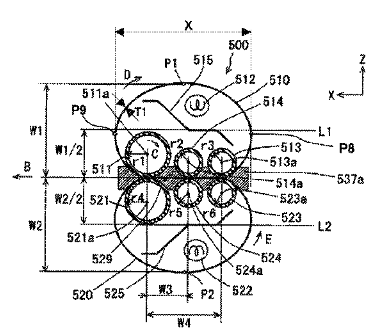
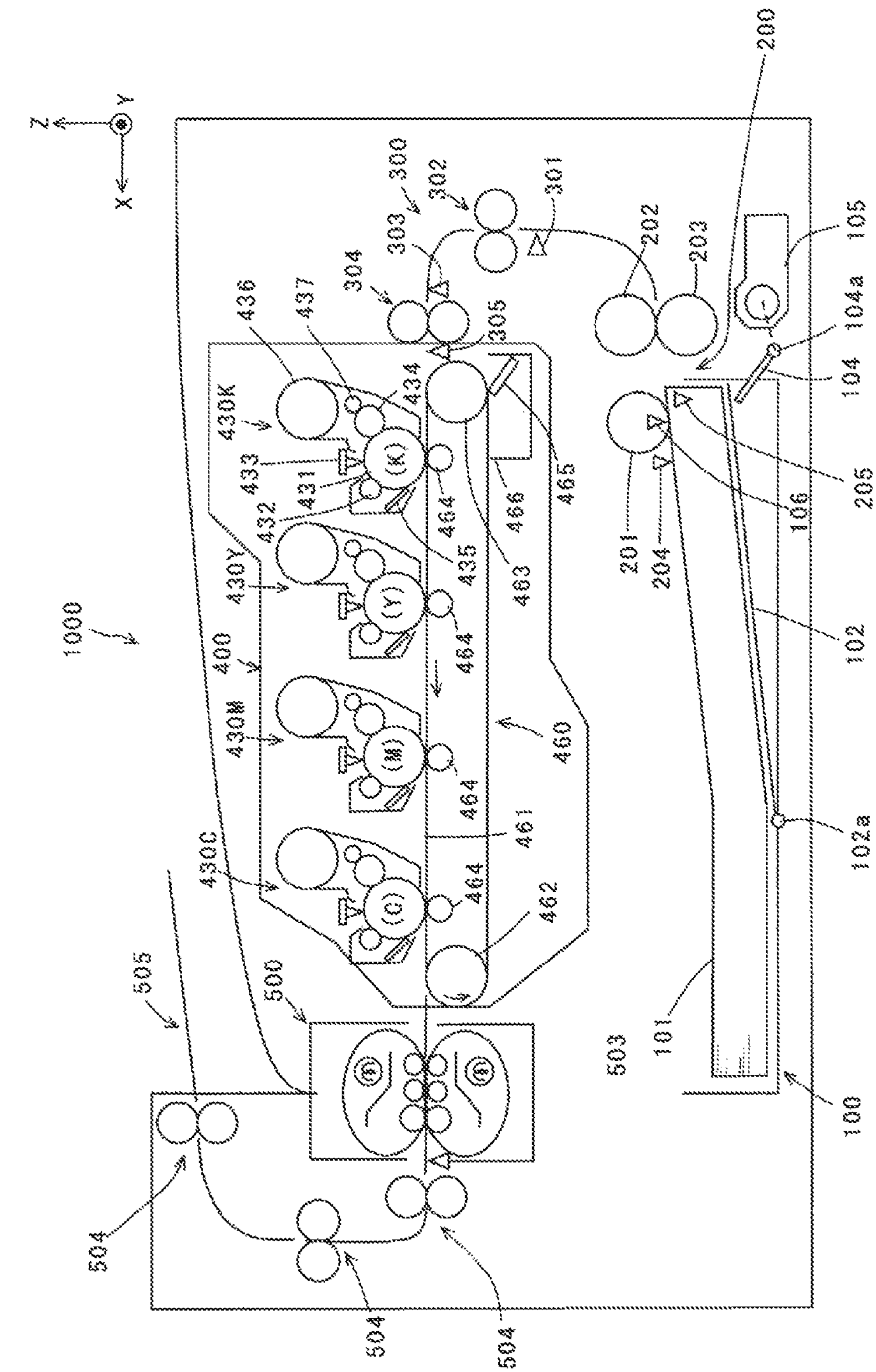


Fig. 1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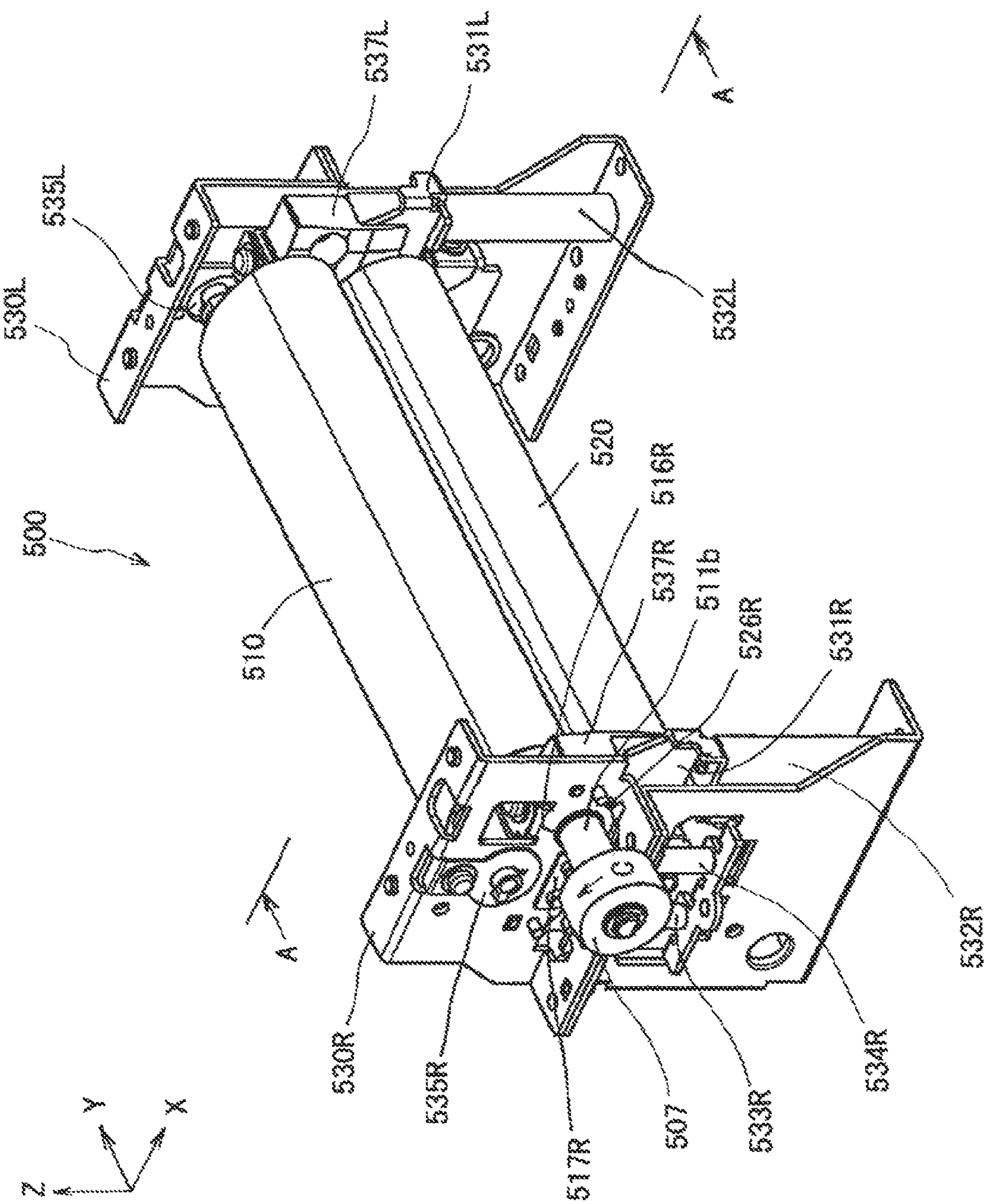
(M)
(C)

Fig. 2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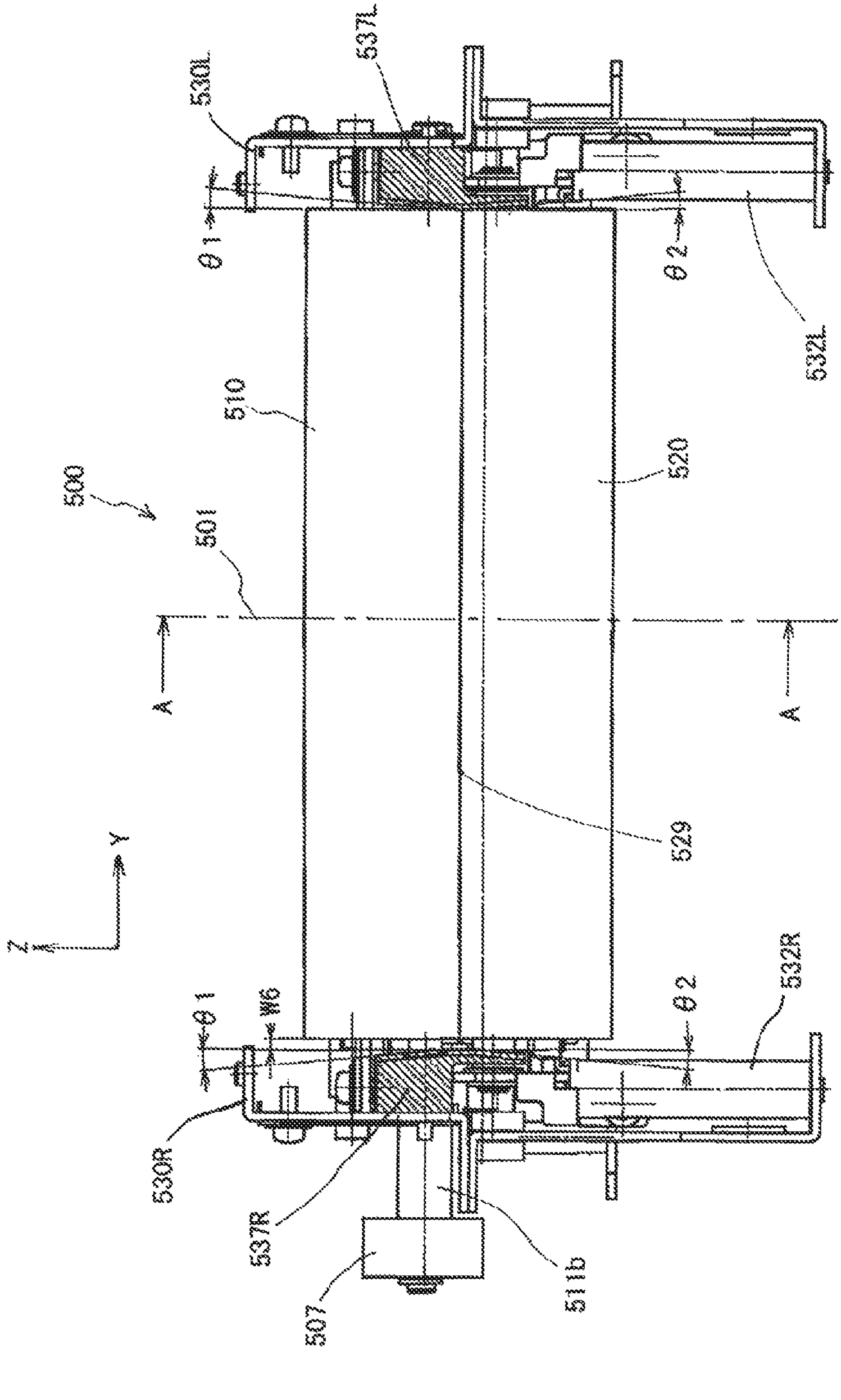
533R
507
517R
535R
530R
C
X
Y
Z

Fig. 3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θ2
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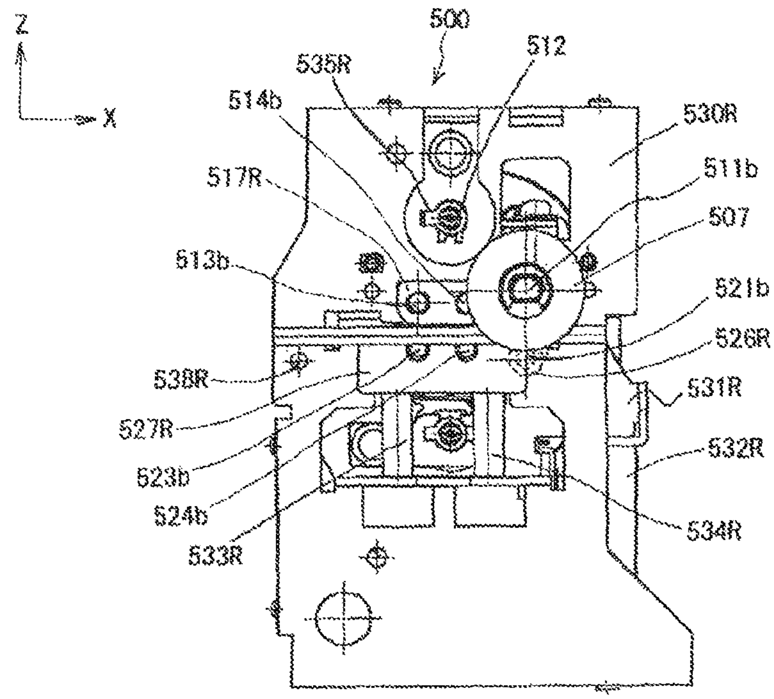
537R
507
511b

Fig. 4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532R
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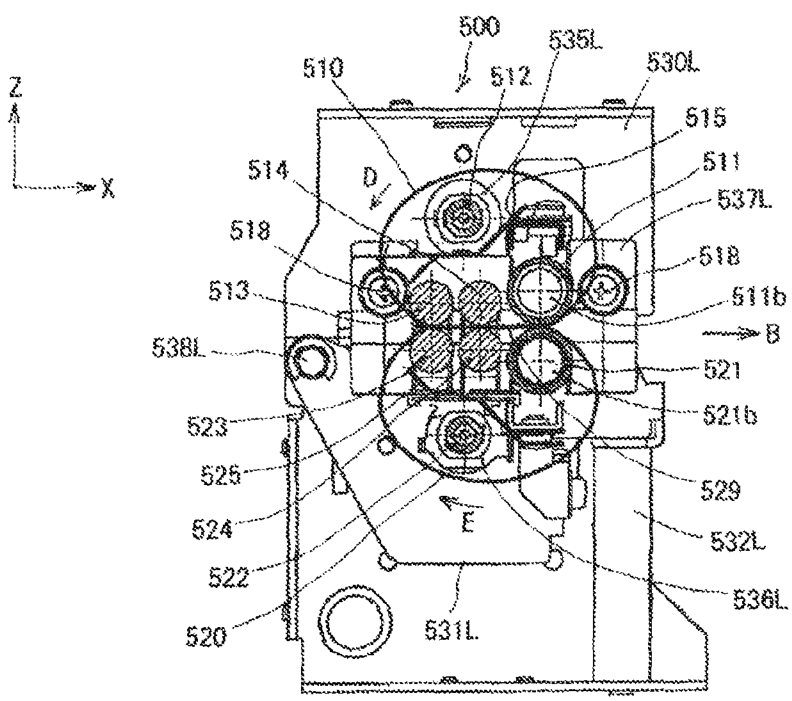
524b
534R
533R

Fig. 5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524
E
532L
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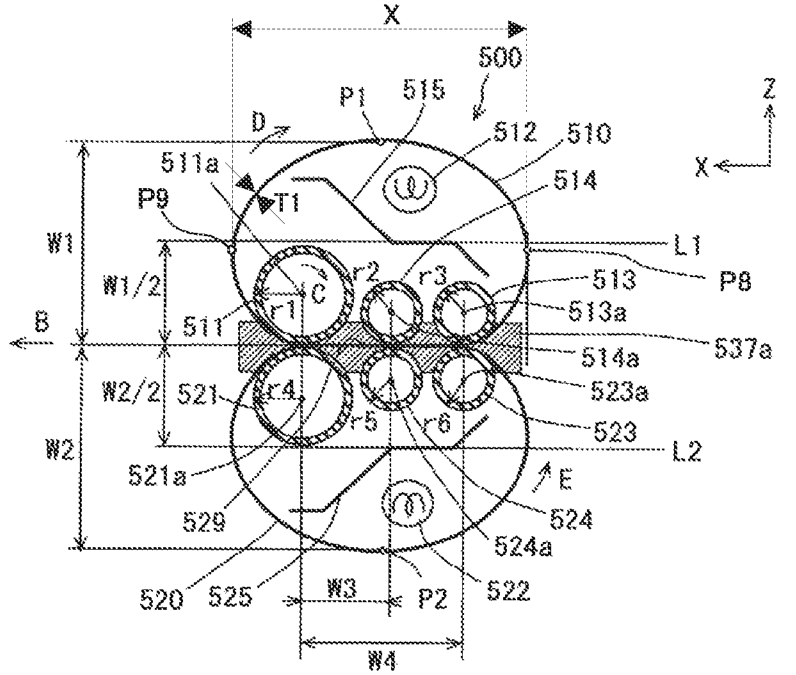
536L
520
531L

Fig. 6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T1
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P9
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r3
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W1/2
C
r1
513a
B
511
514a
537a
W2/2
521
r4
523a
r5
r6
523
W2
L2
521a
E
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524
524a
520
525
W3
P2
522
W4
Z
X

Fig. 7

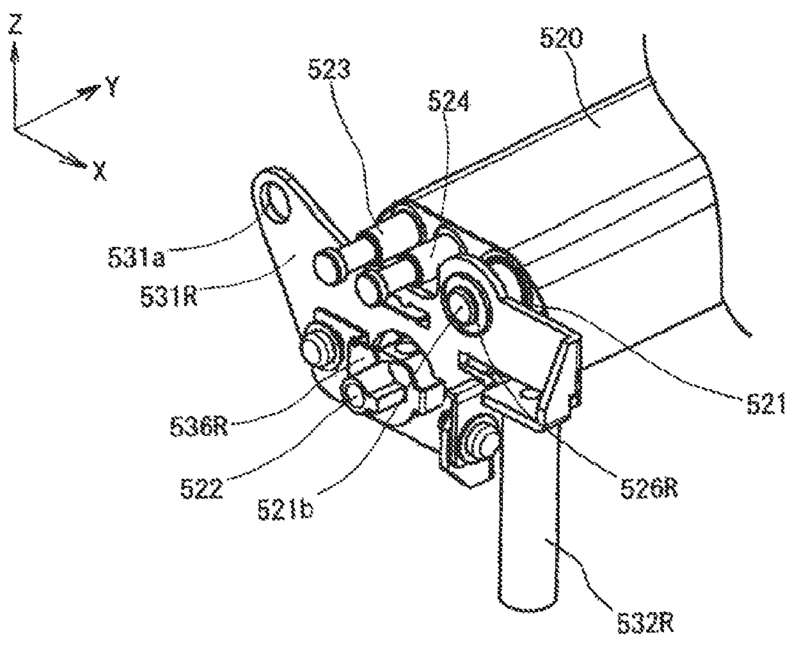
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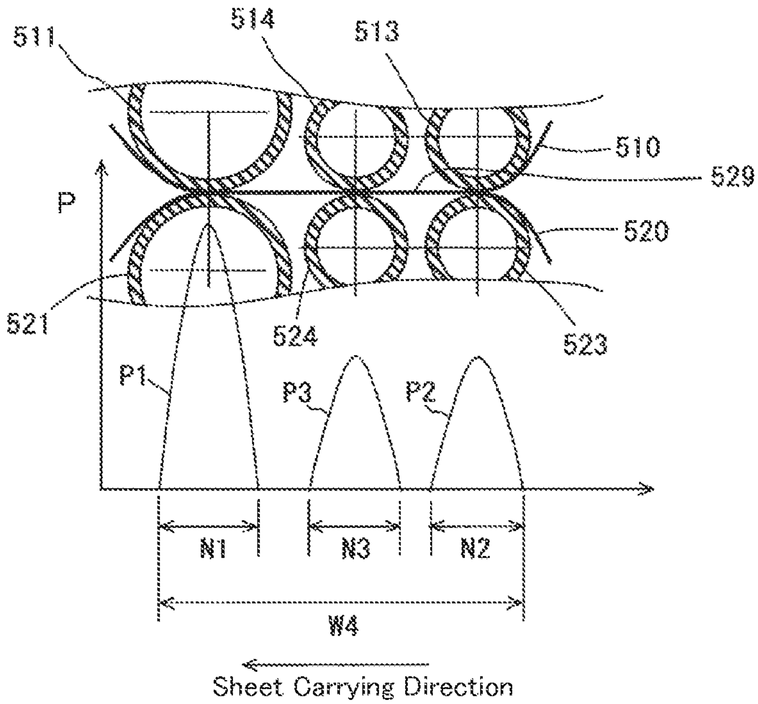
Fig. 8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P
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P3
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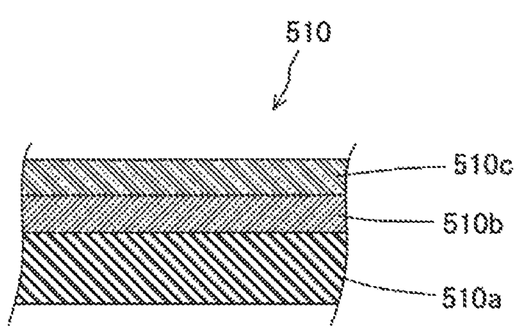
N1
N3
N2
W4
Sheet Carrying Direction

Fig. 9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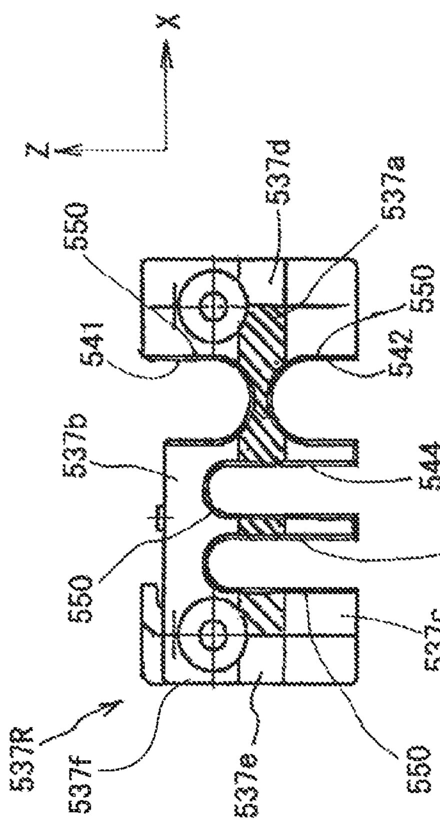

Fig. 10A

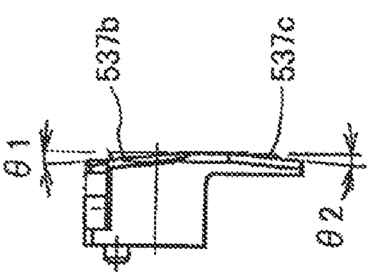

Fig. 10B

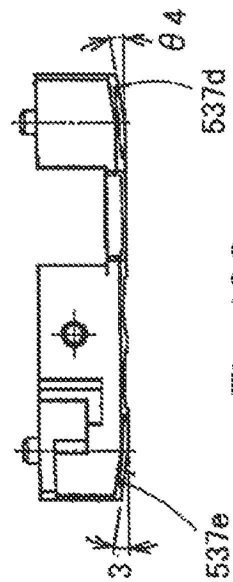

Fig. 10C

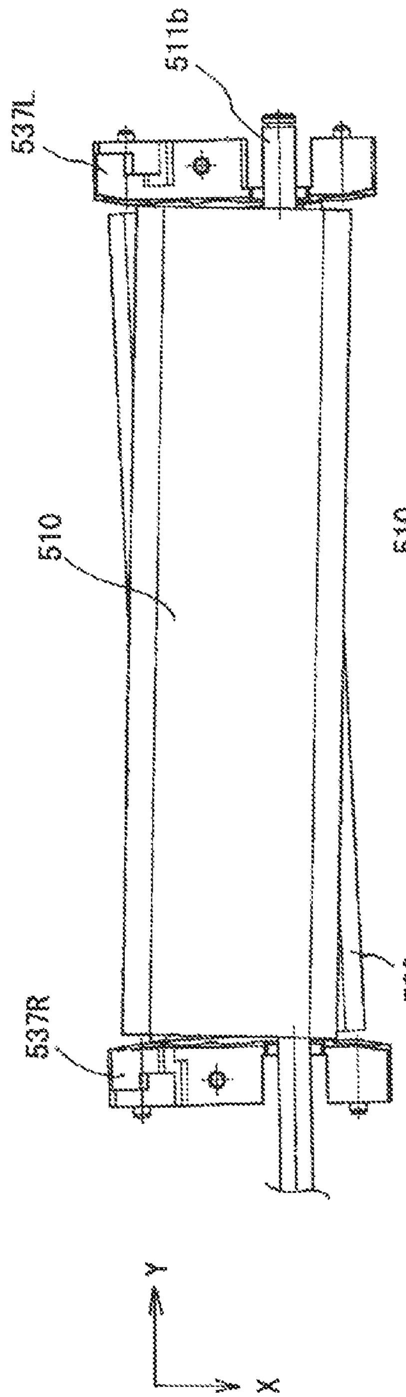

Fig. 11A

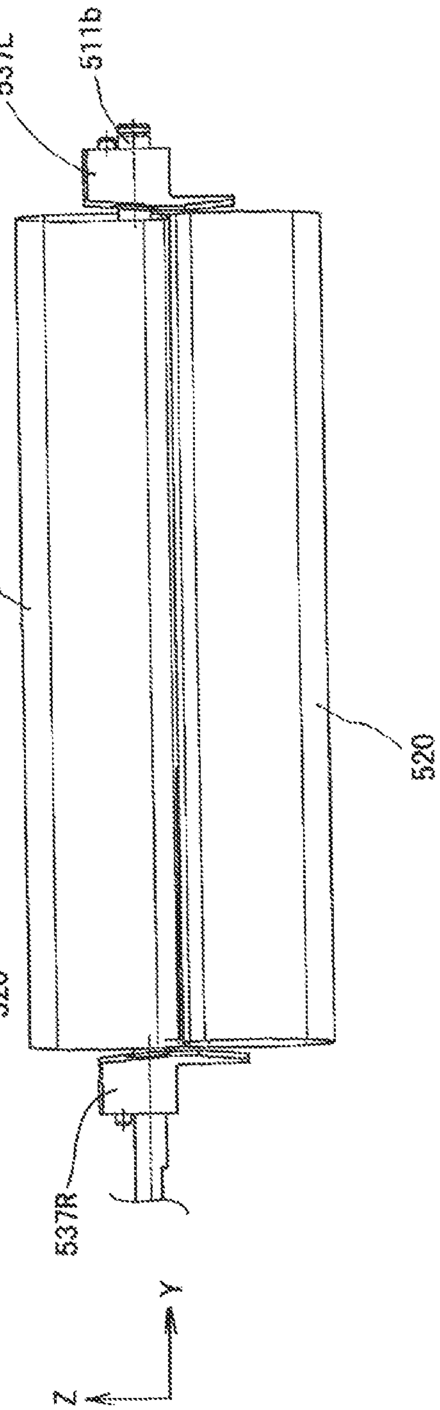

Fig. 11B

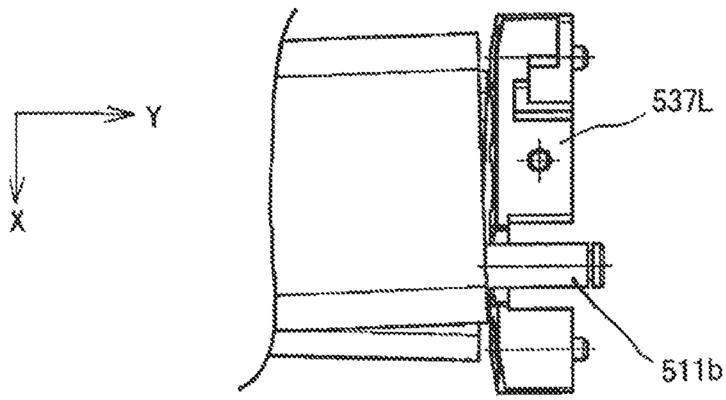

Fig. 12A

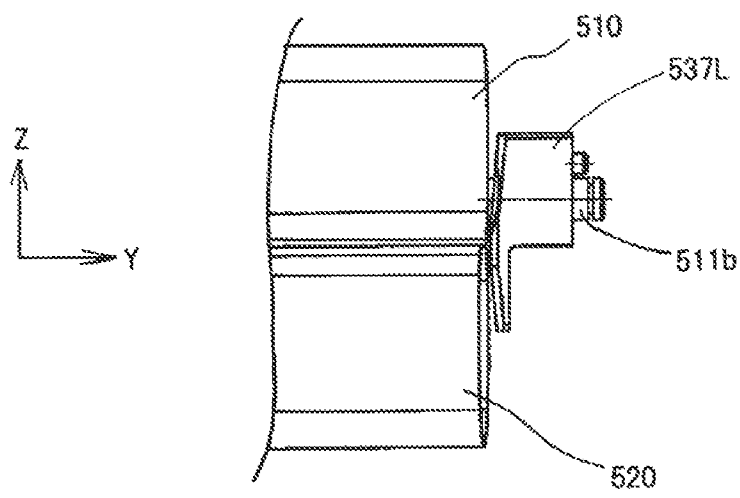

Fig. 12B

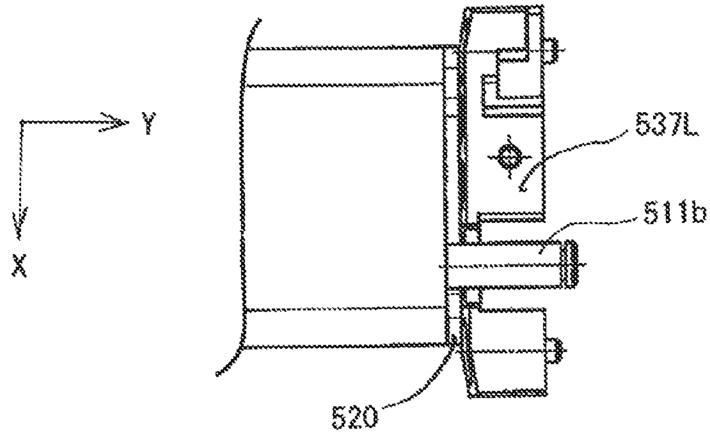

Fig. 13A

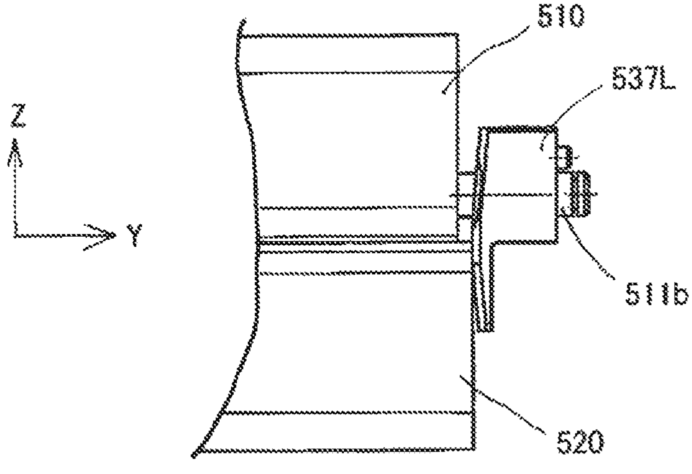

Fig. 13B

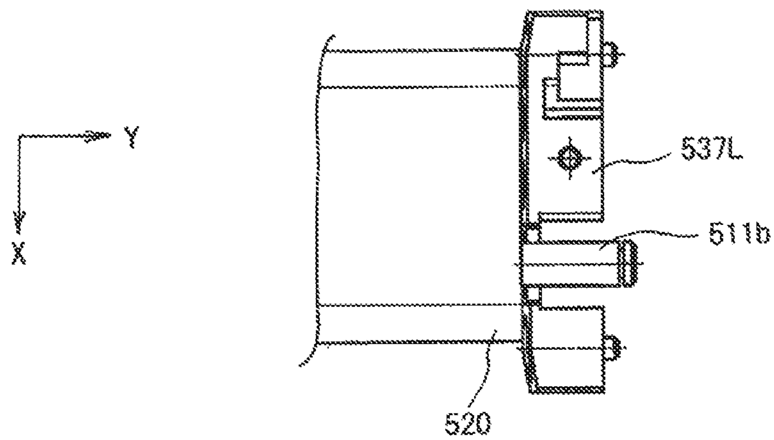

Fig. 14A

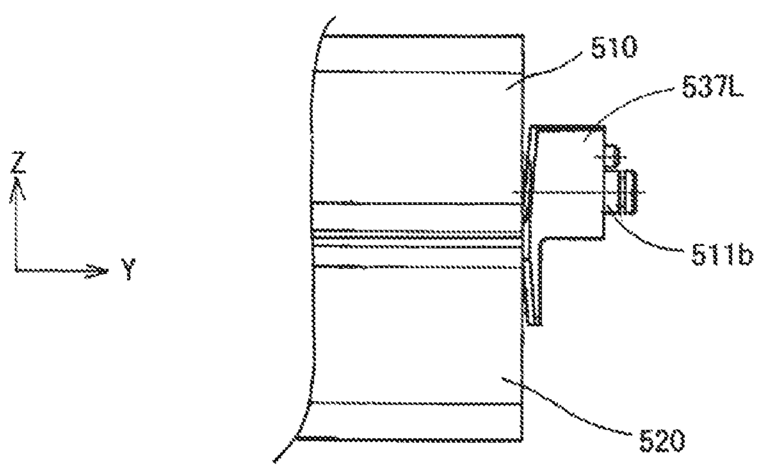

Fig. 14B

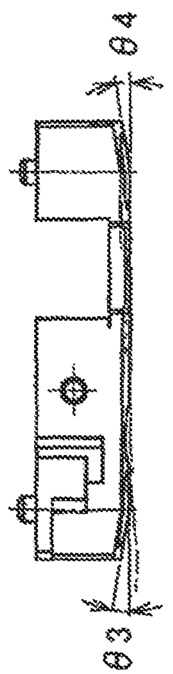

Fig. 15C

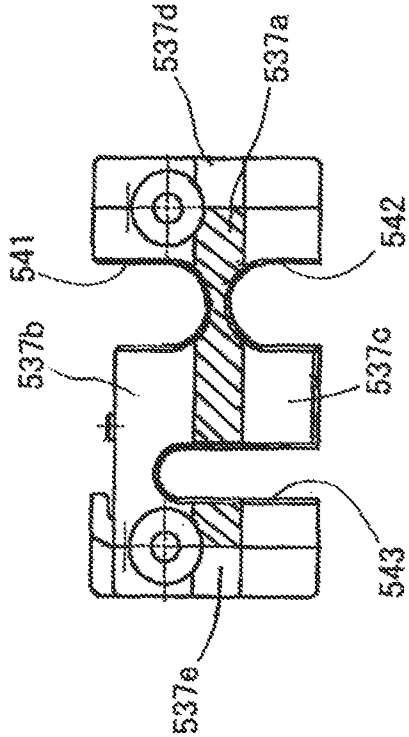

Fig. 15A

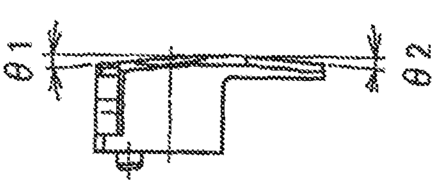

Fig. 15B

Fig. 16

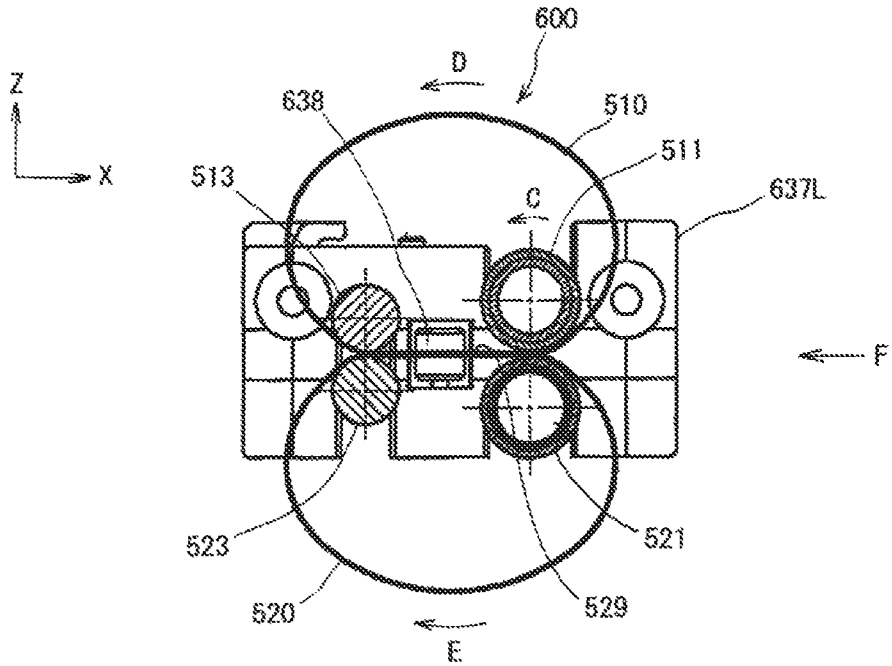
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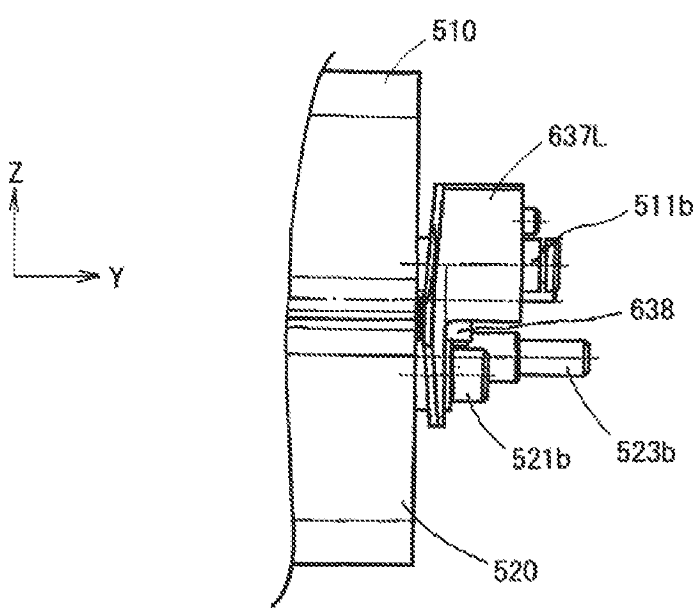
Fig. 17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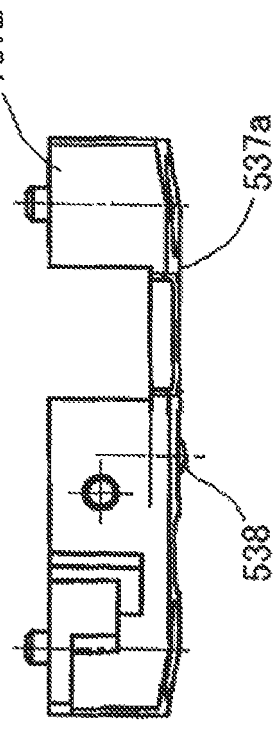


Fig. 18C

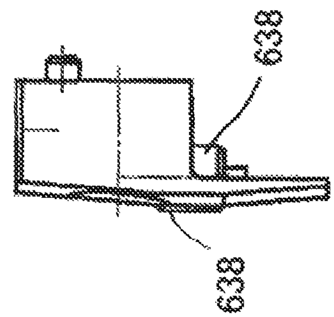


Fig. 18B

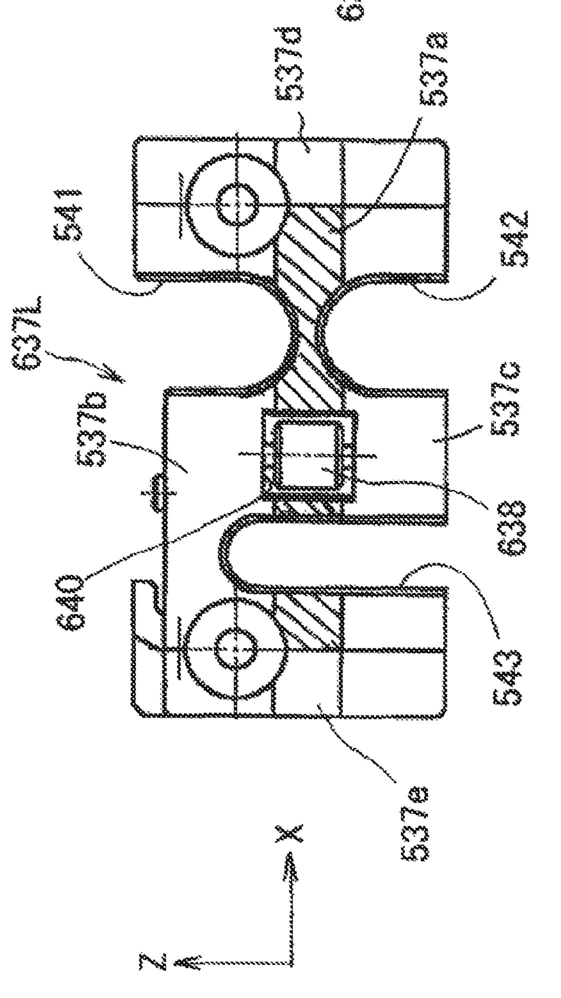
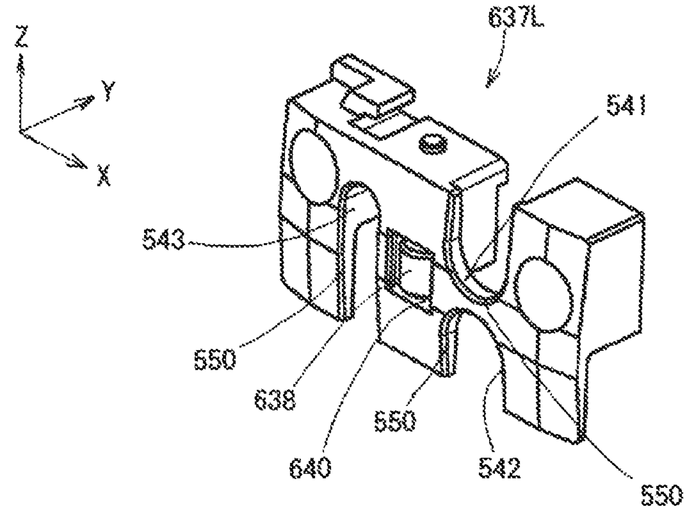


Fig. 18A

Fig. 19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550

Fig. 20

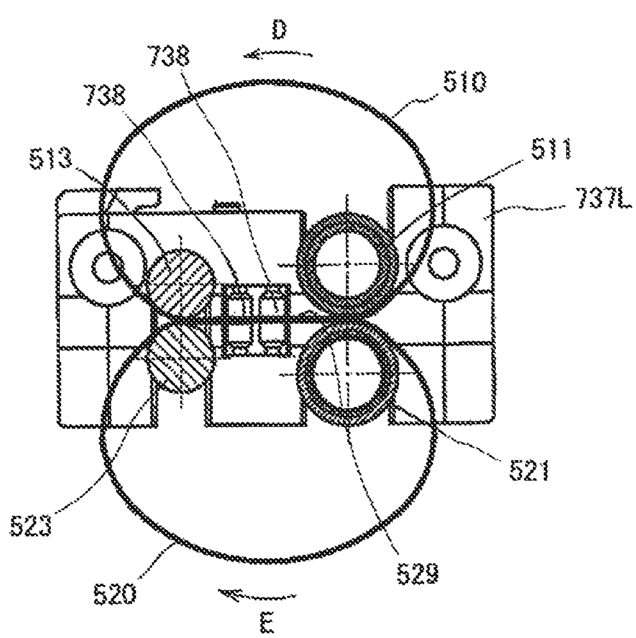
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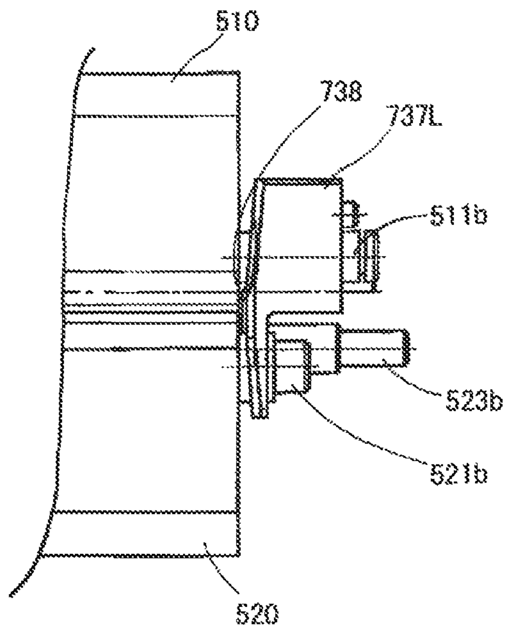
Fig. 21



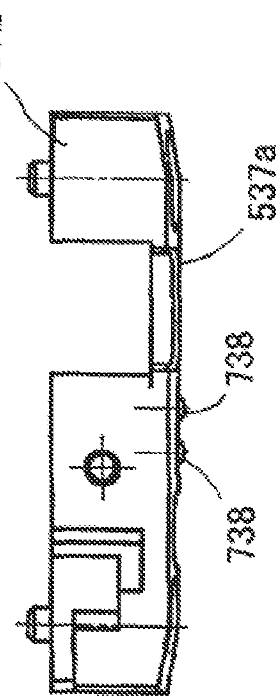
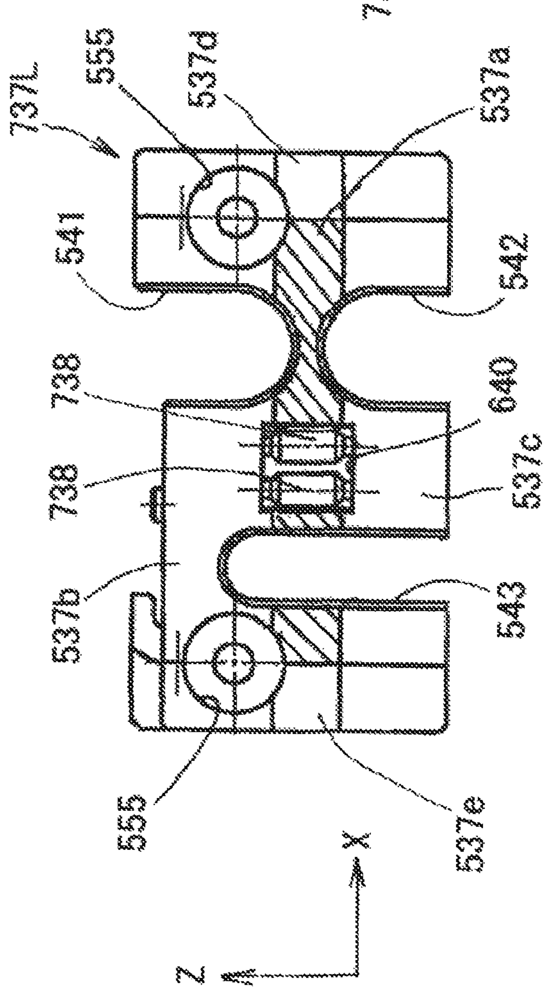


Fig. 22C



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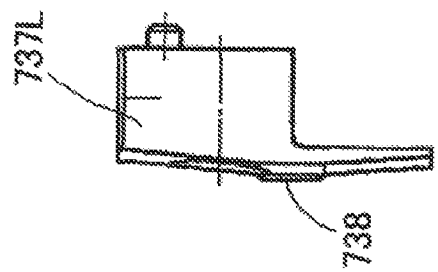


Fig. 22B

Fig. 23

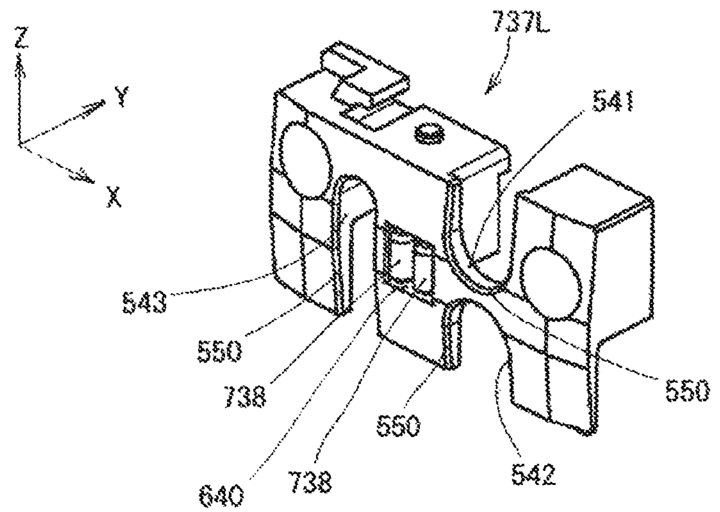
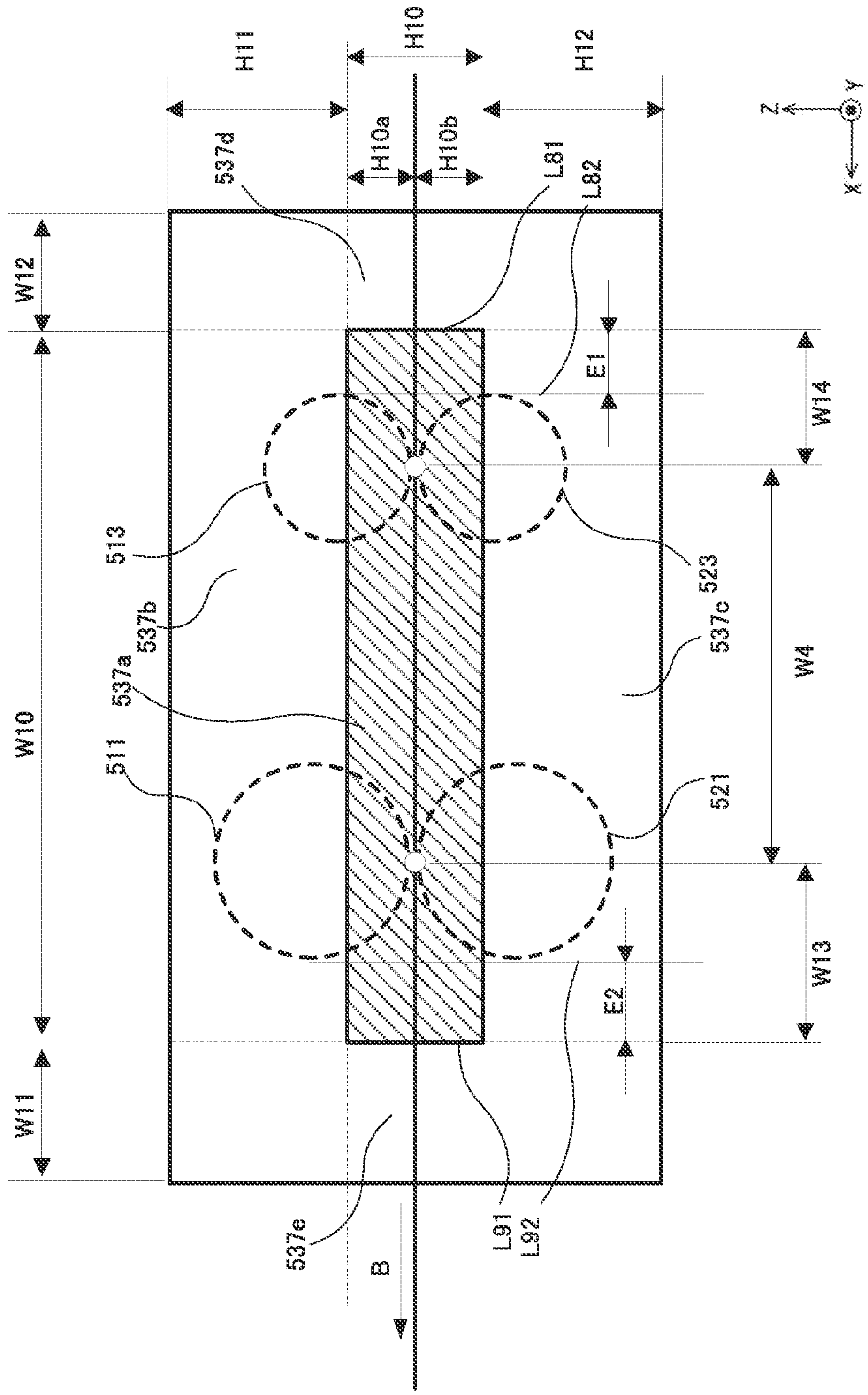


Fig. 24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FUSER DEVICE AND IMAGE FORMING APPARATUS

CROSS REFERENCE TO RELATED APPLICATION

The present application is related to, claims priority from and incorporates by reference Japanese Patent Application No. 2012-224123, filed on Oct. 9, 2012.

TECHNICAL FIELD

This invention relates to a fuser device and an image forming apparatus with the fuser, the image forming apparatus being such as a photocopy machine, a facsimile, a printer, a multifunction machine, and the like.

BACKGROUND

Conventionally, there is a fuser device that has a configuration wherein a nip area is formed by a fuser belt and fusion of a record medium is performed when it goes through the nip area (for example, refer to JP Laid-Open Patent Application 2009-151115).

However, in the fuser device having the above-described configuration, the belt twists in a width direction of the fuser belt at the nip area, and this may cause unfavorable effects to fusion function.

SUMMARY

A fuser device disclosed in the application for fusing a developer image on a medium by applying heat and pressure includes: a belt part that has an endless shape and that is configured to rotate in a tension free state to carry the medium in a medium carrying direction; a first nip forming part that is arranged inside the belt part; a second nip forming part that is arranged outside the belt part to face the first nip forming part, and configured to apply a pressure toward the first nip forming part, sandwiching the belt part with the first nip forming part so that a nip area is formed therebetween, the developer image on the medium being fused during passing the nip area; and a regulation member that regulates a movement of the belt in a width direction of the belt part. The regulation member is configured with a belt regulation part and a slant part, the belt regulation part has a flat shape that is arranged near one of side edges of the belt part along the nip area with a predetermined gap (W6). The slant part extends from an edge of the belt regulation part.

According to the present invention, the belt twist in the width direction at the nip area is prevented. Further, by this prevention, the fuser belt is' prevented from being damaged.

BRIEF DESCRIPTIONS OF THE DRAWINGS

FIG. **1** is a main part configuration view schematically illustrating a main part configuration in the first embodiment of an image forming apparatus according to the present invention.

FIG. **2** is an appearance perspective view of a fuser unit in the first embodiment.

FIG. **3** is a front view of the fuser unit viewed from the x-axis plus side in FIG. **2**.

FIG. **4** is a side view of the fuser unit viewed from the y-axis minus side in FIG. **2**.

FIG. **5** is an inside configuration view of the fuser unit, illustrating the cross section A-A illustrated in FIG. **2** viewed from the y-axis minus side.

FIG. **6** is an explanatory view to explain the basic configuration of the fuser unit in the first embodiment.

FIG. **7** is a partial perspective view partially illustrating a pressure application roller lever of the right side and members related to this.

FIG. **8** is an explanatory view to explain the pressure distribution of the nip area in the first embodiment.

FIG. **9** is a partial cross sectional view to explain a laminate structure of the fuser belt.

FIGS. **10**A, **10**B, and **10**C are configuration views illustrating the form of a belt guide in FIG. **3**. FIG. **10**A is a front view thereof, FIG. **10**B is a left side view thereof, and FIG. **10**C is a top view thereof.

FIGS. **11**A and **11**B are explanatory views illustrating the positional relation of a drive roller, right and left belt guides, the fuser belt, and the pressure application belt when the fuser unit is assembled in the first embodiment. FIG. **11**A is a front view thereof, and FIG. **11**B is a top view thereof.

FIGS. **12**A and **12**B are movement explanatory views to explain the movement of the fuser belt and the pressure application belt at an activation time when the rotation of the drive roller is started. FIG. **12**A is a front view thereof, and FIG. **12**B is a top view thereof.

FIGS. **13**A and **13**B are movement explanatory views to explain the movement of the fuser belt and the pressure application belt at the activation time when the rotation of the drive roller is started. FIG. **13**A is a front view thereof, and FIG. **13**B is a top view thereof.

FIGS. **14**A and **14**B are movement explanatory views to explain the movement of the fuser belt and the pressure application belt at the activation time when the rotation of the drive roller is started. FIG. **14**A is a front view thereof, and FIG. **14**B is a top view thereof.

FIGS. **15**A, **15**B, and **15**C are configuration views illustrating an example of another form of the belt guide in the first embodiment. FIG. **15**A is a front view thereof, FIG. **15**B is a left side view thereof, and FIG. **15**C is a top view thereof.

FIG. **16** is an inside configuration view of a fuser unit in the second embodiment viewed from the direction corresponding to the cross section A-A illustrated in FIG. **2** as being similar to FIG. **5**.

FIG. **17** is a side view of the fuser unit in FIG. **16** viewed from the direction of the arrow F.

FIGS. **18**A, **18**B, and **18**C are configuration views illustrating the form of a belt guide illustrated in FIG. **16**. FIG. **18**A is a front view thereof, FIG. **18**B is a right side view thereof, and FIG. **18**C is a top view thereof.

FIG. **19** is an appearance perspective view of the belt guide illustrated in FIG. **16**.

FIG. **20** is an inside configuration view illustrating an example of another configuration of the belt guide in the second embodiment.

FIG. **21** is a side view of the fuser unit illustrated in FIG. **20**.

FIGS. **22**A, **22**B, and **22**C are configuration views illustrating the form of the belt guide in FIG. **20**. FIG. **22**A is a front view thereof, FIG. **22**B is a right side view thereof, and FIG. **22**C is a top view thereof.

FIG. **23** is an appearance perspective view of the belt guide illustrated in FIG. **20**.

FIG. **24** is an explanatory view to explain the scales of the nip area and the peripheries.

DETAILED DESCRIPTIONS OF PREFERRED EMBODIMENTS

First Embodiment

FIG. **1** is a main part configuration view schematically illustrating a main part configuration in the first embodiment of an image forming apparatus according to the present invention.

An image forming apparatus **1000** illustrated in FIG. **1** is provided with a configuration as, for example, a color electrographic printer. In FIG. **1**, a sheet feeding tray **100** is detachably installed in the image forming apparatus **1000** main body and accommodates a record sheet **101** as a medium that is stacked inside. Inside the sheet feeding tray **100**, a sheet place pallet **102** is rotatably disposed at a support shaft **102***a*, and the record sheet **101** is placed on the sheet place pallet **102**. Also, in the sheet feeding tray **100**, a guide member (not illustrated) to regulate the stack position of the record sheet **101** is disposed, and it guides the feeding direction of the record sheet **101** and the direction that is perpendicular with respect to the feeding direction and maintains the stack position of the record sheet **101** that is held inside in a certain position.

At the side of the record sheet feeding direction of the sheet feeding tray **100**, a lift up lever **104** is rotatably disposed at a support shaft **104***a*, and the support shaft **104***a* is detachably engaged with a motor **105**. When the sheet feeding tray **100** is installed in the image forming apparatus **1000** main body, the lift up lever **104** and the motor **105** are engaged, and a control part (not illustrated) drives the motor **105**. Thereby, the lift up lever **104** rotates so that the tip part of the lift up lever **104** lifts up the bottom part of the sheet place pallet **102** as the support shaft **102***a* is the center of the rotation and elevates the record sheet **101** that is stacked on the sheet place pallet **102**. When the record sheet **101** is elevated to the certain height, the elevation detection part **106** detects it, and the control part (not illustrated) stops the motor **105** based on the information detected by the elevation detection part **106**.

At the side of the feeding direction of the sheet feeding tray **100**, a sheet feeding part **200** (or medium feeding part) to feed the record sheet **101** one by one is disposed. At the sheet feeding part **200**, a pick-up roller **201** to contact and press the record sheet **101** that is elevated to the certain height and a roller pair of a feed roller **202** and a retard roller **203** to separate the record sheet **101** one by one that is fed by the pick-up roller **201** are disposed. Also, at the sheet feeding part **200**, a sheet existence detection part **204** to detect whether the record sheet **101** exists or not and a sheet residual quantity detection part **205** to detect the sheet residual quantity are disposed.

The record sheet **101** separated one by one and fed by the sheet feeding part **200** is sent to a sheet carrying part **300**. The record sheet **101** fed by the sheet feeding part **200** passes through a sheet sensor **301**, and is sent to a carrying roller pair **302**. By a drive part (not illustrated), the carrying roller pair **302** is started to rotate at a timing that is delayed for the predetermined time from the time when the record sheet **101** passes through the sheet sensor **301**. Thereby, the record sheet **101** is stuffed into a pressing part of the carrying roller pair **302** in a state where the sheet slightly tiles, pressing part and the skew is corrected. The record sheet **101** that is sent by the carrying roller pair **302** passes through a sheet sensor **303** and, it is sent to a carrying roller pair **304**. The carrying roller pair **304** is rotated by the drive part (not illustrated) from the time when the record sheet **101** passes through the sheet sensor **303**, and it sends the record sheet **101** without stopping. The record sheet **101** that is sent by the carrying roller pair **304** passes through a writing sensor **305**, and it is sent to an image forming part **400**.

The image forming part **400** consists of a toner image forming part **430**K that contains black toner (K), a toner image forming part **430**Y that contains yellow toner (Y), a toner image forming part **430**M that contains magenta toner (M), and a toner image forming part **430**C that contains cyan toner (C), which are lined up from the upstream side in the feeding direction of the record sheet **101** in series, (hereinafter those are referred to as the toner image forming part **430** when they are not needed to be distinguished) and a transfer part **460** to transfer a toner image formed by the toner image forming part **430** to the top surface of the record sheet **101** by the Coulomb force.

The four toner image forming parts **430** lined up in series all have the same configuration. Only the toner colors that are used, that is, black (K), yellow (Y), magenta (M), and cyan (C), are different. Therefore, here, the inside configuration of the black toner image forming part **430**K that is arranged at the most upstream side in the sheet carrying direction of the record sheet is explained as an example.

The toner image forming part **430** is provided with a photosensitive drum **431** to hold the toner image, a charge roller **432** to charge the surface of the photosensitive drum **431**, a LED head **433** that consists of LED array to form an electrostatic latent image on the surface of the charged photosensitive drum **430**, a development roller **434** to form a toner image on the electrostatic latent image by the frictional charge, a toner contain part **436** to supply toner, a supply roller **437** to supply toner from the toner contain part **436** to the development roller **434**, a cleaning blade **435** to scrape the remaining toner on the surface of the photosensitive drum **431** after the transfer, and the like.

The transfer part **460** consists of an endless transfer belt **461** that electrostatically sticks and carries the record sheet **101**, a drive roller **462** that is rotated in the arrow direction by the driven part (not illustrated) and moves and drives the transfer belt **461**, a tension roller **463** that makes a pair with the drive roller **462** and stretches the transfer belt **461**, four transfer rollers **464** that are arranged so as to respectively face, contact and press the photosensitive drums **431** of the toner image forming parts **430** and apply the voltage so as to transfer the toner images to the record sheet **101**, a cleaning blade **465** that scrapes and cleans the toner attached on the transfer belt **461**, and a toner box **466** that piles up the toner scraped off by the cleaning blade **465**.

The toner image forming part **430** and the transfer belt **461** are driven at the same time, and sequentially pile and transfer each color of the toner images to the record sheet **101** that is electrostatically stuck and carried by the transfer belt **461**. In this way, the record sheet **101** on which the toner image is transferred at the image forming part **400** is sent to a fuser unit **500** as a fuser device where the toner image is fused and stuck to the record sheet **101** by heat and pressure.

The fuser unit **500** applies heat and pressure to the toner image on the record sheet **101** that is sent in the carrying direction of the record sheet by the image forming part **400** and melts the toner image to fuse it on the record sheet **101**. After that, the record sheet **101** where the fusion is conducted is ejected to a stacker part **505** by an ejection roller pair **504**.

Regarding the axes X, Y, and Z in FIG. **1**, when the record sheet **101** passes through the image forming part **400**, the carrying direction of the record sheet **101** is the x-axis, the rotation shaft direction of the photosensitive drum **431** is the y-axis, and the direction perpendicular to these X and Y axes is the z-axis.

Also, in other figures described later, when X, Y, and Z axes are illustrated, these axes directions show the same directions. That is, X, Y, and Z axes in each figure show the arrangement direction when the part illustrated in each figure configures the image forming apparatus **1000** in FIG. **1**. Also, here, the z-axis is arranged to be the almost vertical direction.

FIG. **2** is an appearance perspective view of the fuser unit **500** in the present embodiment, FIG. **3** is the front view viewed from the x-axis plus side, FIG. **4** is the side view viewed from the y-axis minus side, FIG. **5** is the inside configuration view viewed from the cross section A-A illustrated in FIG. **2**, and FIG. **6** is the explanatory view to explain the basic configuration of the fuser unit **500**. Referring to these figures, the configuration of the fuser unit **500** is explained. FIG. **6** shows the configuration viewed from the opposite side with respect to FIG. **5**.

As illustrated in FIG. **6**, the fuser unit **500** is provided with a fuser belt **510** as an endless belt part (or first belt part) and a pressure application belt **520** as a second belt part. Inside the fuser belt **510**, a drive roller **511** as a first roller (or first nip forming part) to support a straight line movement path of the fuser belt **510** as contacting the inside surface of the fuser belt **510**, a driven roller **513** as a third roller (or third nip forming part), and an auxiliary roller **514** as a fifth roller (or fifth nip forming part) are arranged. Inside the pressure application belt **520**, a pressure application roller **521** as a second nip forming part to support a straight line movement of the pressure application belt **520** as contacting the inside surface of the pressure application belt **520**, a driven pressure application roller **523** as a fourth roller (or fourth nip forming part), an auxiliary pressure application roller **524** as a sixth roller (or fourth nip forming part) are arranged. The above first to sixth nip forming parts are configured with rollers. As long as these nip forming parts can create the nip area therebetween by pinching the fuser belt **510**, it is not necessary to use rollers. Pads instead of rollers are applicable. Also, a combination of pads and rollers may be applicable in an engineering view.

The drive roller **511** and the pressure application roller **521** that are pressed each other via the fuser belt **510** and the pressure application belt **520** are arranged at the downstream side in the carrying direction (the arrow B direction) of the record sheet. Likewise, the driven roller **513** and the driven pressure application roller **523** that are pressed each other via the fuser belt **510** and the pressure application belt **520** are arranged at the upstream side in the carrying direction of the record sheet.

Likewise, the auxiliary roller **514** and the auxiliary pressure application roller **524** that are pressed each other via the fuser belt **510** and the pressure application belt **520** are arranged in the middle of these rollers. The pressing part of each roller pair is arranged on the straight line along the carrying path of the record sheet so that the nip area is formed. The nip area is defined from the pressing part of the driven roller **513** and the driven pressure application roller **523** to the pressing part of the drive roller **511** and the pressure application roller **521**. The width of this nip area is referred to as a total nipping width W**4**.

FIG. **8** is an explanatory view to explain the pressure distribution of the nip area. As illustrated in FIG. **8**, at a nip area **529** with the total nipping width W**4**, a nipping pressure P**1** of the nipping N**1** formed by the pressure application roller **521** and the drive roller **511**, a nipping pressure P**2** of the nipping N**2** formed by the driven pressure application roller **523** and the driven roller **513**, a nipping pressure P**3** of the nipping N**3** formed by the auxiliary pressure application roller **524** and the auxiliary roller **514** are generated. Here, the nipping pressures are set to be

$$P1>P3=P2$$

(however, those are compared with the maximum value of each nipping pressure).

Here, the fuser belt **510** is not stretched between the drive roller **511** and the driven roller **513**, and the pressure application belt **520** is also not stretched between the pressure application roller **521** and the driven pressure application roller **523**, either. These belts are arranged to travel/rotate in a tension free state. That is, "tension free or tension free state", here, means that the fuser belt **510** and the pressure application belt **520** that form the nip area **529** are able to travel/rotate without any supporting parts for traveling. Namely, a pressure or stress is applied to only at the nip area **529**. To realize the tension free state, it is required to use a belt with a predetermined firmness. More specifically described, the tension free state may be defined as a state where, for the fuser belt **510**, there is no tension/stress applied to the belt **510** in the sheet carrying direction. With respect to the tension fee state and the belt that is able to travel in the tension free state, the present application is incorporated by reference with U.S. patent application, Ser. No. 14/018,920 filed on Sep. 5, 2013.

Therefore, the nip area **529** here is formed only by the first pair of rollers configured by the drive roller **511** and the pressure application roller **521**, the second pair of rollers configured by the auxiliary roller **514** and the auxiliary pressure application roller **524**, the third pair of rollers configured by the driven roller **513** and the driven pressure application roller **523**, and the fuser belt **510** and the pressure application belt **520** that are nipped by each roller pair.

Thereby, as illustrated in FIG. **9** that is the partial cross sectional view, the fuser belt **510** (here, the pressure application belt **520** has the same configuration) has a base material **510***a* at the internal circumference surface, an elastic layer **510***b* at the external circumference of the base material **510***a*, and a release layer **510***c* at the external circumference of the elastic layer **510***b*, and the base material **510***a* is an endless belt consists of a metal with elasticity such as SUS and the like. The thickness of the base material **510***a* is approximately 40 μm to 70 μm, and it is preferable that the belt itself has moderate rigidity and flexibility. The elastic layer **510***b* is a silicone rubber layer formed on the base material **510***a*. Also, the release layer is a fluorine-based resin layer such as PFA, PTFE, and the like formed on the elastic layer, and it is formed on the elastic layer by covering of the tube, coating, or the like. It is possible to form a direct release layer on the base material without forming an elastic layer and use it. Also, the base material **510***a* may be an endless belt consists of a resin such as PI and the like.

As illustrated in FIG. **6**, here, the rotation center **511***a* of the drive roller **511**, the rotation center **513***a* of the driven roller **513**, and the rotation center **514***a* of the auxiliary roller **514** are configured to be positioned closer to the nip area **529** than to the belt center L**1** of the fuser belt **510** in the tension free state. The belt center L**1** is determined to be a half of a distance W**1** (W**1**/**2**). Wherein the distance W**1** is determined as a distance from an internal circumference end part P**1** of the fuser belt **510** to the nip area **529** in the z-axis direction. In the embodiment, the end part P**1** is determined when the fusion belt **510** does not travel. Putting it another way, radiuses r**1**, r**2**, r**3** of the rollers **511**, **513**, **514** are smaller than a quarter of the distance W**1**.

Similarly, the rotation center **521***a* of the pressure application roller **521**, the rotation center **523***a* of the driven pressure application roller **523**, and the rotation center **524***a* of the auxiliary pressure application roller **524** are configured to be positioned closer the nip area **529** than to the belt center L**2** of the pressure application **520** in the tension free state. The belt center L**2** is determined to be a half of a distance W**2** (W**2**/**2**). Wherein the distance W**2** is determined as a distance from an internal circumference end part P**2** of the pressure application belt **520** to the nip area **529** in the negative z-axis direction. In the embodiment, the end part P**2** is determined when the pressure application belt **520** does not travel. Putting it another way, radiuses r**4**, r**5**, r**6** of the rollers **521**, **523**, **524** are smaller than a quarter of the distance W**2**.

At the internal circumference of the fuser belt **510**, a heater **512** as a heat application source is arranged. Here, a halogen heater is used as the heater **512**. However, instead of this halogen heater, an induction heating body and the like may be used. Also, a reflection plate **515** is arranged so that the heat from the heater **512** does not directly heat the drive roller **511**, the driven roller **513**, or the auxiliary roller **514**. Here, the reflection plate **515** is used. However, instead of this reflection plate **515**, a halogen heater with a reflection film, which is a halogen heater that has a reflection film, may be used.

Similarly, at the internal circumference of the pressure application belt **520**, a heater **522** as a heat application source is arranged. Here, a halogen heater is used as the heater **522**. However, instead of this halogen heater, an induction heating body and the like can be used. Also, a reflection plate **525** is arranged so that the heat from the heater **522** does not directly heat the pressure application roller **521**, the driven pressure application roller **523**, or the auxiliary pressure application roller **524**. Here, the reflection plate **525** is used. However, instead of this reflection plate **525**, a halogen heater with a reflection film, which is a halogen heater that has a reflection film, may be used.

As illustrated in FIG. **5**, in the present embodiment, when the heater **512** as the heat application source is viewed from the rotation shaft direction of the drive roller **511**, it is arranged at the upstream side of the drive roller **511** in the carrying direction of the record sheet (the direction of the arrow B) and at the area between the auxiliary roller **514** and/or the driven roller **513** and the internal circumference surface of the fuser belt **510**. Similarly, the heater **522** is also arranged at the upstream side of the pressure application roller **521** in the carrying direction of the record sheet, and at the area between the auxiliary pressure application roller **524** or/and the driven pressure application roller **523** and the internal circumference surface of the pressure application belt **520**.

As being more specifically explained, the heater **512** is arranged at the upstream side of the drive roller **511** in the carrying direction of the record sheet, and at the area between the outer tangent line that is opposite to the nip area **529** of the auxiliary roller **514** and the driven roller **513** and the internal circumference surface of the fuser belt **510**. Similarly, the heater **522** is arranged at the upstream side of the pressure application roller **521** in the carrying direction of the record sheet, and at the area between the outer tangent line that is opposite to the nip area **529** of the auxiliary pressure application roller **524** and the driven pressure application roller **523** and the internal circumference surface of the pressure application belt **520**.

As described later, the drive roller **511** rotates in the direction of the arrow C (FIG. **6**) accepting a driving force from outside and drives the moving member such as other rollers and belts and the like. Thereby, the fuser unit **500** carries the record sheet **101** on which the toner image is transferred but not fused yet to the arrow B direction while nipping at the nip area **529**, and melts the toner to fuse the toner image at the same time.

The fuser unit **500** is further provided with following basic characteristics. Respective rotation centers **521***a* and **511***a* of the pressure application roller **521** and the drive roller **511** are arranged on the same surface that is almost perpendicular with respect to the carrying direction of the record sheet. Here, the almost perpendicular means that the surface is at an angle in the range of 85 degrees to 95 degrees with respect to the carrying direction of the record sheet. The driven pressure application roller **523** is arranged to face the driven roller **513**, and it is pressurized via the fuser belt **510** and the pressure application belt **520** to the driven roller **513**. Respective rotation centers **523***a* and **513***a* of the driven pressure application roller **523** and the drive roller **513** are arranged on the same surface that is almost perpendicular with respect to the carrying direction of the record sheet. Here, the almost perpendicular means that the surface is at an angle in the range of 85 degrees to 95 degrees with respect to the medium carrying direction. The auxiliary pressure application roller **524** is arranged to face the auxiliary roller **514**, and it is pressurized via the fuser belt **510** and the pressure application belt **520** to the auxiliary roller **514**. Respective rotation centers **524***a* and **514***a* of the auxiliary pressure application roller **524** and the auxiliary roller **514** are arranged on the same surface that is almost perpendicular with respect to the carrying direction of the record sheet. Here, the almost perpendicular means that the surface is at an angle in the range of 85 degrees to 95 degrees with respect to the medium carrying direction. The pressure application roller **521**, the fuser belt **510**, and the pressure application belt **520** are driven and rotated accompanied by the rotation in the arrow C direction of the drive roller **511**, and the driven pressure application roller **523**, the driven roller **513**, the auxiliary pressure application roller **524**, and the auxiliary roller **514** are driven and rotated accompanied by the rotation in the arrow D direction of the fuser belt **510** and the rotation in the arrow E direction of the pressure application belt **520**.

Considering the point above, the configuration of the fuser unit **500** of the embodiment is further explained.

As illustrated in FIG. **2**-FIG. **5**, the rotation shaft **511***b* of the drive roller **511** that is arranged inside the fuser belt **510** is rotatably maintained in brackets **530**R and **530**L that are arranged to face each other at the right and left sides of the device (refer to FIG. **2**) via bearings **516**R and **516**L (**516**L is not illustrated) that are fixed on the each bracket. One end side of the rotation shaft **511***b* penetrates the bracket **530**R and extends and exists outside the bracket **530**R in the shaft direction of the rotation shaft **511***b*, and a driving gear **507** is fixed at the end part.

As described later, in order to support the drive roller **511**, the driven roller **513**, the auxiliary roller **514**, the pressure application roller **521**, the driven pressure application roller **523**, and the auxiliary pressure application roller **524** at the both sides of each of the rollers, the brackets **530**R, **530**L and the like are arranged in a plane symmetry configuration to face each other at the right and left sides with respect to a virtual plane **501** (FIG. **3**) that perpendicularly crosses in the middle sections of the drive roller **511** and the fuser unit **500**. Therefore, when viewed from the negative side of the x-axis (back side of the sheet surface of FIG. **3**), the symmetry members are distinguished by adding the letter R (for the member of the right side) or L (for the member of the left side) at the end. When it is not necessary to distinguish L or R, these letters at the end sometimes are omitted.

As being similar to the drive roller **511**, a rotation shaft **513***b* and a rotation shaft **514***b* of the driven roller **513** and the auxiliary roller **514** that are arranged inside the fuser belt **510** (FIG. **5**) are also rotatably maintained by bearings **517**R and **517**L (**517**L is not illustrated) fixed on the brackets **530**R and **530**L. In the embodiment, as the bearing for the driven roller **513** and the auxiliary roller **514**, a bearing that is integrally formed is used. However, instead of this bearing, a bearing that individually maintains each roller may be used.

In contrast, a rotation shaft **521***b* of the pressure application roller **521** that is arranged inside the pressure application belt **520** is rotatably supported by pressure application roller levers **531**R and **531**L (FIG. **2**) via bearings **526**R and **526**L (**526**L is not illustrated) respectively fixed on the pressure application roller levers.

FIG. **7** is a partial perspective view partially illustrating the pressure application roller lever **531**R and the member related to this. This pressure application roller lever **531**R is arranged inside the bracket **530**R in FIG. **2**.

As illustrated in FIG. **7**, the pressure application roller lever **531**R that rotatably holds the pressure application roller **521** is provided with a fulcrum **531***a* at one end side. By using the fulcrum **531***a* as a pivot, the pressure application roller lever **531**R is rotatably supported with a rotation shaft **538**R (FIG. **4**) that is arranged on the bracket **530**R. At the other end, the pressure application roller lever **531**R is provided with a spring **532**R that is arranged in a state where it is compressed between the pressure application roller lever **531**R and the bracket **530**R. The pressure application roller lever **531**R is biased by this spring **532**R, and the pressure application roller **521** is pressed against the drive roller **511** with the predetermined pressure in a manner of nipping the fuser belt **510** and the pressure application belt **520**.

At this time, as described above, the respective rotation centers **521***a* and **511***a* of the pressure application roller **521** and the drive roller **511** (FIG. **6**) are arranged so as to be on the same surface that is almost perpendicular with respect to the carrying direction of the record sheet. Here, the configuration at the bracket **530**R side is explained. However, as described above, the configuration at the bracket **530**L side that is configured to be the plane symmetry also has a similar configuration. In a practical view, it is not necessary for the left and right brackets to be identical. Considering its required function, the brackets may be customized in a different way.

Being similar to the pressure application roller **521**, the rotation shaft **523***b* and the rotation shaft **524***b* of the driven pressure application roller **523** and the auxiliary pressure application roller **524** that are arranged inside the pressure application belt **520** are rotatably maintained at the one end side (R side) by the bearing **527**R (FIG. **4**) that is slidably maintained on the bracket **530**R. The bearing part **527**R is slidably arranged in the direction of the driven roller **513** and the auxiliary roller **514** with respect to the bracket **530**R, and the spring **533**R and **534**R as the bias member to bias the bearing **527**R are arranged.

The driven pressure application roller **523** is biased toward the driven roller **513** by the spring **533**R, and similarly, the auxiliary pressure application roller **524** is biased toward the auxiliary roller **514** by the spring **534**R. That is, each roller is independently biased by a spring and respectively pressurized by a facing roller. In the embodiment, as a bearing of the driven roller **523** and the auxiliary roller **524**, a bearing that is integrally formed is used. However, instead of this bearing, a bearing that individually maintains each roller may be used. Also, here, the configurations of the bracket **530**R and the pressure roller lever **531**R at R side are explained. However, the configurations of the bracket **530**L and the pressure application roller lever **531**L at L side that are configured to be the plane symmetry have a similar configuration.

Also, the pressing part of each roller pair is arranged on almost the same plane at the nip area **529** (FIG. **6**) so as not to give stress to the fuser belt **510** and the pressure application belt **520**, and the nip area **529** at the total nipping width W**4** forms the straight record sheet carrying part that is almost parallel with respect to the carrying direction of the record sheet.

Here, "almost parallel" ranges within ±5 degrees of the carrying direction of the record sheet. Also, here, "arranged on almost the same plane" means that each roller pair is arranged so that the distance from the line connects the upstream side end part of the pressing part of the drive roller **511** and the pressure application roller **521** in the sheet carrying direction and the downstream side end part of the pressing part of the drive roller **513** and the driven pressure application roller **523** in the sheet carrying direction to the pressing part of the auxiliary roller **514** and the auxiliary pressure application roller **524** becomes 20% or less of the roller radius r**2** of the auxiliary roller **514**.

In FIG. **6**, the total nipping width W**4**, which is from the pressing part of the driven roller **513** and the driven pressure application roller **523** to the pressing part of the drive roller **511** and the pressure application roller **521**, can be changed by moving the position of the driven roller **513** and the driven pressure application roller **523**, which make a pair, in the record sheet carrying direction.

Also, by changing the arrangement number of the auxiliary roller **514** and the auxiliary pressure application roller **524** that make a pair and are arranged between the drive roller **511** and the pressure application roller **521** that make a pair and the driven roller **513** and the driven pressure application roller **523** that make a pair, the pressure distribution can be changed.

In order to prevent the belt pressure from relieving, each roller is arranged so as to fill the shaft intervals as much as possible. Also, from the point of view of the heat transfer, it is preferable that the interval of the rollers that are next to each other is smaller than the circumference length of the roller at the upstream side in the record sheet carrying direction.

Here, considering the point described above, each roller is configured as illustrated in FIG. **6**. The roller radius r**2** of the auxiliary roller **514** that is adjacent to the drive roller **511** and arranged at the upstream side in the carrying direction of the record sheet of the drive roller **511** is formed to be smaller than the roller radius r**1** of the drive roller **511**. Similarly, the roller radius r**5** of the auxiliary pressure application roller **524** that is adjacent to the pressure application roller **521** and arranged at the upstream side in the carrying direction of the record sheet of the pressure application roller **521** is formed to be smaller than the roller radius r**4** of the pressure application roller **521**.

The roller radius r**1** of the drive roller **511** and the roller radius r**4** of the pressure application roller **521** are almost the same.

Similarly, the roller radius r**2** of the auxiliary roller **514** and the roller radius r**5** of the auxiliary pressure application roller **524** are almost the same. Here, considering a dimensional error of a processing accuracy and the like, "approximately the same" may be within ±10% of one roller radius out of the pair of rollers to form the nip via the fuser belt **510** and the pressure application belt **520**. For example, it is $0.9\times r1 \le r4 \le 1.1\times r1$.

The roller radius r**3** of the driven roller **513** that is adjacent to the auxiliary roller **514** and arranged at the upstream side in the carrying direction of the record sheet of the driven roller **514** is formed to be smaller than the roller radius r**1** of the drive roller **511** and almost the same as the roller r**2** of the auxiliary roller **514**. Here, considering a dimensional error of a processing accuracy and the like, "almost the same" may have a relationship of $0.9\times r2 \leq r3 \leq 1.1\times r2$.

Similarly, the roller radius r**6** of the driven pressure application roller **523** that is adjacent to the auxiliary pressure application roller **524** and arranged at the upstream side in the carrying direction of the record sheet of the auxiliary pressure application roller **524** is formed to be smaller than the roller radius r**4** of the pressure application roller **521** and approximately same as the roller radius r**5** of the auxiliary pressure application roller **524**. Here, considering a dimensional error of a processing accuracy and the like, "almost the same" may have a relationship of $0.9\times r5 \leq r6 \leq 1.1\times r5$.

When the distance between each shaft **511***a* and **514***a* of the drive roller **511** and the auxiliary roller **514** in the carrying direction of the record sheet is W**3**, the drive roller **511** and the auxiliary roller **514** are arranged so as to be $2\times r1 > W3$. Also, when the thermal expansion of the roller member by the rise of the temperature inside the device is considered, it is preferable to be $2\times r1\times 1.2 > W3$. Similarly, when the distance between each shaft **521***a* and **524***a* of the pressure application roller **521** and the auxiliary pressure application roller **524** in the carrying direction of the record sheet is W**3'**, the pressure application roller **521** and the auxiliary pressure application roller **524** are arranged so as to be $2\times r4 > W3'$. Also, when the thermal expansion of the roller member by the rise of the temperature inside the device is considered, it is preferable to be $2\times r4\times 1.2 > W3'$. W**3** and W**3'**, are almost the same. Here, considering a dimensional error of a processing accuracy and the like, "almost the same" may be the relationship of $0.9\times W3' \leq W3 \leq 1.1\times W3'$.

The drive roller **511**, the driven roller **513**, the auxiliary roller **514**, the pressure application roller **521**, the driven pressure application roller **523**, and the auxiliary pressure application roller **524** are formed by covering a shaft of an iron metal core with an elastic layer with a heat-resistant property that consists of a silicone rubber. In the embodiment, the rubber hardness of the elastic layer is ASKER-C75-85°. Also, in order to secure the uniform pressure distribution, the elastic layer may be formed with a low hardness (ASKER-C50-60°) foaming silicone rubber or a further lower hardness (ASKER-C30-40°) liquid silicone rubber.

The both ends of the heater **512** that is disposed inside the fuser belt **510** are supported by the heater support part **535**R that is disposed on the bracket **530**R and the heater support part **535**L disposed on the bracket **530**L. As illustrated in FIG. **7** and FIG. **5**, the both ends of the heater **522** that is disposed inside the pressure application belt **520** are supported by the heater support part **536**R that is disposed on the pressure application roller lever **531**R and the heater support part **536**L that is disposed on the pressure application roller lever **531**L.

At the both sides in the width direction of the fuser belt **510** and the pressure application belt **520**, the belt guide **537**R and **537**L are arranged as regulation members to regulate the twist of the fuser belt **510** and the pressure application belt **520** at the nip area **529** and to manipulate the oblique motion. As illustrated in FIG. **5**, the belt guide **537**L is positioned by the bracket **530**L and fastened by the screw **518**. Here, the installation of the belt guide **537**L is explained. However, the belt guide **537**R that is configured to be the plane symmetry is similarly installed at the bracket **530**R.

As illustrated in FIG. **3**, in the width direction of the fuser belt **510** and the pressure application belt **520**, between the fuser belt **510** and the belt guides **537**R, **537**L and between the pressure application belt **520** and the belt guides **537**R, **537**L, the predetermined gap W**6** as the belt movable range is disposed so that the belt guides **537**R, **537**L do not always contact the fuser belt **510** and the pressure application belt **520**. In the embodiment, the gap W**6** is 2 mm. It is preferred that the gap W**6** is within 1 mm to 5 mm. The gap W**6** is a margin disposed at the belt guide **537**R side in order to reduce a carrying load on the fuser belt **510**. The carrying load is created by the belt guide **537** R excessively regulating the movement of the fuser belt **510** in its width direction when the fuser belt **510** is thermally expanded due to an environmental change. Specifically, in FIG. **3**, the gap W**6** is defined and measured as a gap between the plane **537***a* of the belt guide **537**R and a side edge of fuser belt **510** under a condition where the other side edge of the fuser belt **510** contacts the other plane **537***a* of the belt guide **537**L. Of course, where the side edge of fuser belt **510** contacts the belt guide **537**R, the gap W**6** is created at the belt guide **537**L side.

FIGS. **10**A-**10**C are configuration views illustrating the form of the belt guide **537**L that is illustrated in, for example, FIG. **3**. FIG. **10**A is the front view, FIG. **10**B is the left side view, and FIG. **10**C is the top view.

This belt guide **537**L is arranged to be perpendicular to the record sheet carrying surface of the fuser belt **510** and the pressure application belt **520** (including the nip area **529**) and to be parallel to the carrying direction of the record sheet, and this belt guide **537**L has the plane **537***a* (the hatching part) as the belt regulation part to regulate the movement in the belt width direction by regulating the side edges of the fuser belt **510** and the pressure application belt **520**. This plane **537***a* is arranged to overlap an upstream area. The upstream area means an area in the upstream side of the sheet carrying direction from a point where the fuser belt **510** and the pressure application belt **520** meets. The point may be defined as a nipping point by the rollers **513** and **523**. In FIG. **6**, the upstream area is shown at the right side of the rollers **513** and **523**.

Here, when the belt guide **537**L is positioned on the bracket **530**L by the screw **518**, the plane **537***a* is formed so as to fill the following condition. As illustrated FIG. **6**, it is preferable that the plane **537***a* is formed at the position to face the nip area **529** that is between the rotation center **511***a* of the drive roller **511** and the rotation center **521***a* of the pressure application roller **521** in the direction (the z-axis direction) perpendicular with respect to the nip area **529** that is the carrying surface of the record sheet. In the embodiment, the plane **537***a* is formed between the rotation center **513***a* of the driven roller **513** and the rotation center **523***a* of the driven pressure application roller **523**.

As illustrated in FIG. **6**, the right edge of the plane **537***a* is formed right to an imaginary connecting line between the two rotation centers **513***a* and **523***a*, and left to point P**8** which is the most upstream point of the fuser belt **510** in the carrying direction of the record sheet. In other word, the most upstream edge of the plane **537***a* is located at the downstream side from point P**9**, and at the upstream side from the nip area **529**. Also, the left edge of the plane **537***a* is formed left to an imaginary connecting line between the two rotation centers **511***a* and **521***a*, and right to point P**9** which is the most downstream point of the fuser belt **510** in the carrying direction of the record sheet. In other words, the most downstream edge of the plane **537***a* is located at the upstream side from point P**9**, and at the downstream side from the nip area **529**. The plane **537***a* is formed in order to overlap further upstream area from the nip area **529** and further downstream area from the nip area **529**. The example range of the plane **537***a* described above is the shaded part in FIG. **6**.

In FIG. **10**, each slope **537***b*, **537***c*, **537***d*, and **537***e* is the slant part that is adjacent farther outside to the plane **537***a*.

Each of the slopes **537***b*, **537***c*, **537***d*, and **537***e* has a slant in a direction separating from the side edge of the fuser belt **510** and the pressure application belt **520**, that is, in a direction in which the plane **537***a* projects. Each of the slopes **537***b*, **537***c*, **537***d*, and **537***e* has a shape that is tapered with θ**1**, θ**2**, θ**3**, and θ**4** angle. The taper angles θ**1**, θ**2**, θ**3**, and θ**4** are determined considering strength and a twisting amount of belt. The taper angles θ**1**, θ**2**, θ**3**, and θ**4** are formed in order not to contact a belt that is twisted to some degree. However, when the belt is twisted more than the degree and contacts the slopes, the slopes function to smoothly guide the belts toward the plane **537***a* so that the twisted state is canceled when the belt returns the plane **537***a*. In the embodiment, the taper angles θ**1**, θ**2**, θ**3**, and θ**4** are set 5 degrees. Considering features of conventional fuser belts or pressure application belts, the taper angles θ**1**, θ**2**, θ**3**, and θ**4** may be 3 to 7 degrees. It is not necessary for the slopes to be flat. It may be a curved surface. In case of the curved surface, the taper angles can be determined with representative scales of the slopes.

Further, a surface that is adjacent to edges of the plane **537***a*, which is for example a surface **537***f* adjacent to the slope **537***e* and **537***b* in FIGS. **10**A and **10**C, may be a plane in which each ridge lines with the slopes **537***e* and **537***b* is formed straight shown in FIG. **10**A, or in which one inclined ridge line is formed by intersecting the slopes **537***e* and **537***b*. Other parts as well are the same.

Here, when the belt guide **537**L is positioned at the bracket **530**L by the screw **518**, each slope **537***b*, **537***c*, **537***d*, and **537***e* has the following characteristics.

i) The slope **537***e* as a taper at the upstream side in the carrying direction of the record sheet is the surface that extends from the plane **537***a* toward the upstream side in the carrying direction of the record sheet, and as it goes toward the upstream side in the carrying direction of the record sheet, in the belt width direction, the slant part separates more from each side edge of the fuser belt **510** and the pressure application belt **520**.

ii) The slope **537***d* as a taper at the downstream side in the carrying direction of the sheet record is the plane that extends from the plane **537***a* toward the downstream side in the carrying direction of the record sheet, and as it goes toward the downstream side in the direction of the record sheet, in the belt width direction, the slant part separates more from each side edge of the fuser belt **510** and the pressure application belt **520**.

iii) The slope **537***b* as a taper is the plane that extends from the plane **537***a* and the nip area **529** toward the direction where the drive roller **511** is arranged, as it separates from the nip area **529** in the same direction, in the belt width direction, the slant part separates more from each end of the fuser belt **510** and the pressure application belt **520**.

iv) The slope **537***c* as a taper is the plane that extends from the plane **537***a* and the nip area **529** toward the direction where the drive roller **511** is arranged, as it separates from the nip area **529** in the same direction, in the belt width direction, the slant part separates more from each end of the fuser belt **510** and the pressure application belt **520**.

Further, on the belt guide **537**L, the longhole **541** and the longhole **542** along which shafts of the drive roller **511** and the pressure application roller **521** are allowed to move are formed so that the belt do not contact the belt guide **537**L. The longhole **543** along which shafts of the driven roller **513** and the driven pressure application roller **523** are allowed to move, and the longhole **544** along which shafts of the auxiliary roller **514** and the auxiliary pressure application roller **524** are allowed to move are formed so that the belt do not contact the belt guide **537**L. On the belt side of each longhole, the chamfering process **550** is chamfered to make the edges smooth. However, instead of the chamfering process **550**, they can be chamfered with a rounded corner.

Also, on the belt guide **537**L, the concave part **555** with a penetration hole to fasten the screw **518** is formed. When the concave part **555** fixes the screw **518** on the concave part **555**, it is formed so that the screw head of the screw **518** does not protrude from the plane **537***a* and each slope **537***b*, **537***c*, **537***d*, and **537***e*.

The belt guide **537**L is the part where the fuser belt **510** and the pressure application belt **520** slide, and also it is used at the part where the temperature becomes high that is the fuser part. Therefore the belt guide **537**L needs to have a highly slidable and highly heat resistant function, so it is formed by a high performance resin such as PPS, LCP, PEEK, PI, and the like.

Here, the configuration of the belt guide **537**L is explained. However, as described above, the belt guide **537**R that is configured to be the plane symmetry also has a similar configuration.

In the configuration described above, the movement of the fuser unit **500** in the embodiment is explained.

Accompanied by the print start in the image forming apparatus **1000**, the gear **507** for driving that is fixed on the rotation shaft **511***b* of the drive roller **511** rotates in the arrow C direction (FIG. **2**) accepting the rotator power from the drive motor (not illustrated). Accompanied by this, the pressure application roller **521**, the fuser belt **510**, and the pressure application belt **520** are driven and rotated, and further, the driven pressure application roller **523**, the driven roller **513**, the auxiliary pressure application roller **524**, and the auxiliary roller **514** are driven and rotated accompanied by the rotation of the fuser belt **510** and the pressure application belt **520**. At this time, the fuser belt **510** and the pressure application belt **520** respectively rotate in the arrow D direction and the arrow E direction illustrated in FIG. **5**.

In contrast, the heater **512** (FIG. **5**) generates heat because the electric current is supplied from the feeding circuit (not illustrated) and heat the fuser belt **510** from inside. The surface temperature of the fuser belt **510** is detected by the temperature detection means (not illustrated), and based on this detected temperature, it is temperature-controlled to maintain the predetermined fuser temperature by the temperature control part that drives and controls the feeing circuit. Similarly, the heater **522** also generates heat because the electric current is supplied from the feeding circuit (not illustrated) and heat the pressure application belt **520** from inside. The surface temperature of the pressure application belt **520** is detected by the temperature detection means (not illustrated), and based on this detected temperature, it is temperature-controlled to maintain the predetermined fuser temperature by the temperature control part to drive and control the feeing circuit. Additionally, it is possible to control the temperature the temperature control part only arranged at the fuser belt side not at the pressure application belt side.

The record sheet **101** on which the toner image is transferred by the image forming part **400** enters into the nip area **529** of this fuser unit **500** from the upstream side in the carrying direction of the record sheet, it is nipped by the fuser belt **510** that rotates and moves in the arrow D direction and the pressure application belt **520** that rotates and moves in the arrow E direction, and it is carried to the arrow B direction at the nip area **529**. Also, during this process, the heat and pressure are applied, and the toner image is melted and fused on the record sheet **101**.

In the embodiment, FIGS. **11**A and **11**B are explanatory views illustrating the positional relation of the drive roller, the right and left belt guide, the fuser belt, and the pressure application roller when the fuser unit is assembled. FIG. **11**A is the front view, and FIG. **11**B is the top view.

As described above, the nip area **529** (FIG. **5**) is formed in the tension free state, so especially the fuser belt **510** and the pressure application belt **520** are not adjusted and installed when the fuser device **500** is assembled. Thereby, as illustrated in FIG. **11**, in the fuser belt **510** or/and the pressure application belt **520**, the drive roller **511** and the pressure application roller **521**, which make the pair, are misaligned more or less because of a manufacturing error, a assembling error, or the like.

FIG. **12-14** are movement explanatory views to explain the movement of the fuser belt **510** and the pressure application belt **520** at an activation time when the rotation of the drive roller **511** starts in the fuser unit **500** illustrated in FIG. **11**. In each figure, A is the front view, and B is the top view. Also, each figure of FIG. **12-14** is the partial view in vicinity of the engagement part of the belt guide **537**L, the fuser belt **510**, and the pressure application belt **520**.

As illustrated in FIG. **11**, the fuser belt **510** or/and the pressure application belt **520** that make pairs with the drive roller **511** and the pressure application roller **521** (FIG. **5**) are misaligned, and when the drive roller **511** is rotated and driven in the predetermined direction, the fuser belt **510** and the pressure application belt **520** respectively start moving so as to balance themselves following the pressure that is generated by the drive roller **511** and the pressure application roller **521** that make pair with the fuser belt **510** and the pressure application belt **520**. That is, both side edges of each belt that starts traveling/rotating contact each plane **537***a* (refer to FIGS. **6** and **10**) that is disposed on the belt guide **537**L and the belt guide **537**R, and while each belt moves from side to side, the side edges of the belts are gradually lined up and becomes a state where those are properly aligned. Then, the state is maintained.

FIG. **12** illustrates the state that the fuser **510** and the pressure application belt **520** are misaligned in the opposite directions from each other and they abut on the belt guide. FIG. **13** illustrates the state that the fuser belt **510** and the pressure application belt **520** are aligned. However they move their shafts in the opposite directions from each other and abut on the belt guide. FIG. **14** illustrates the state where the fuser belt **510** and the pressure application belt **520** are in the proper state. The proper state means that they are aligned and both side edges are lightly touched or not touched by each plane **537***a* (refer to FIGS. **6** and **10**) disposed on the belt guide **537**L and the belt guide **537**R while the fuser belt **510** and the pressure application belt **520** travels/rotates.

As described above, the side edge of the fuser belt **510** and the pressure application belt **520** except at the nip area **529** rotates in the free sate when it is not at the nip area **529**, so the belt side edge is sometimes twisted as illustrated in FIG. **11**. The free part of the belt only has the rigidity itself, so the rigidity is very weak. If the belt side edge of the free part that is in this twisted state contacts the belt guide **537**, the contact part will be damaged. Thereby, on the belt guide **537** of the embodiment, the taper (the slope **537***b*, **537***c*, **537***d*, and **537***e*, refer to FIG. **10**) is disposed so as to prevent the belt side edge from contacting except at the nip area **529** of the fuser belt **510** and the pressure application belt **520**. Therefore, the belt end part of the fuser belt **510** and the pressure application belt **520** contacts the belt guide **537** only at the joining part (the area where the nip area **529** is formed).

In the embodiment, the guide member **537** that has the first roller pair that is configured by the drive roller **511** and the pressure application roller **521**, the second roller pair that is configured by the auxiliary roller **514** and the auxiliary pressure application roller **524**, and the third roller pair that is configured by the driven roller **513** and the driven pressure application roller **523**, and thereby provided with the long-holes **541**, **542**, **543**, and **544** as illustrated in FIG. **10** is used. However, it is not limited to this. For example, it can be configured without the second roller pair that is configured by the auxiliary roller **514** and the auxiliary pressure application roller **514**. In this case, as illustrated in FIG. **15**, the guide member that is not provided with the longhole **544** to escape the second roller pair can be used.

Also, in the embodiment, the example describe that the fuser unit **500** consists of the fuser belt **510** and the pressure application belt **520** that are endless and seamless belts on top and bottom. However, the invention is not limited to this. Using a combination of a top belt and a bottom roller or a combination of a top roller and a bottom belt, or one or more belts can be applicable.

As described above, according to the fuser unit **500** in the embodiment, at the nip area **529**, the fuser belt **510** and the pressure application belt **520** are guided and the side edges of them are aligned, and each belt is prevented from contacting the guide member except at the nip area **529**. Therefore, the fuser belt **510** and the pressure application belt that form the nip area are properly rotated in the tension free state, and the part of the belt side edge that is freely and unstably rotating does not accept a disturbance from the outside. It is possible to prevent the twisting or waving of the belt and the damage of the belt.

[Scales of Parts]

Using FIGS. **3**, **6** and **24**, scales (or size) of these parts are to be explained in this section. A thickness T**1** of the fuser belt **510** is preferably within 0.05 mm (50 μm) to 0.5 mm (500 μm). In the embodiment, the thickness T**1** is 0.15 mm (150 μm). The fuser belt **520** as well may be configured in the same manner. In light of providing the same heat conductivity, or reducing production cost, it is preferred to use identical belts for the fuser belts **510** and **520**. The actual height W**1** of the fuser belt **510**, which is measured when the fuser belt **510** is equipped, is 28.4 mm. The height W**2** of the fuser belt **520** is the same as the fuser belt **510**.

When a distance from the most upstream point P**8** of the fuser belt **510** to the most downstream point of P**9** in the medium carrying direction B is defined X, the distance X is 40 mm.

Radiuses r**1**, r**4** of drums **511** and **521** are 6 mm Radiuses r**2**, r**3**, r**5** and r**6** are 4 mm. It is preferred that a ratio of (r**1**, r**4**)/(r**2**, r**3**, r**5**, r**6**) is around 1.5. In view of arranging the drums closer, the ratio (r**1**, r**4**)/(r**2**, r**3**, r**5**, r**6**) may be less than 1.5.

Nip width W**4** is 20 mm, a length W**10** of the plane **537***a* is 40.3 mm. It is preferred that the length W**10** is roughly twice as large as the nip width W**4**. Lengths W**11** and W**12** of slopes **537***e*, **537***d* in the medium carrying direction are 6 mm, which are the same. A length W**13**, which is from the most downstream edge of the nip area to the most downstream edge of the plane **537***a*, is 11.6 mm. A length W**14**, which is from the most upstream edge of the nip area to the most upstream edge of the plane **537***a*, is 8.7 mm which is smaller than the length W**13**. Heights H**11** and H**12** of the slopes **537***b*, **537***c* are 10 mm which are identical. The heights H**11** and H**12** are not necessarily identical. A height H**10** of the plane **537***a* is 6 mm. The nip area is created in the middle of the height H**10**, thereby two heights H**10***a* and H**10***b* from the nip are area are both 3 mm. The height H**10***a* is at the drive roller **511** side. The height H**10***b* is at the pressure application roller **521** side. The heights H**10***a* and H**10***b* are not necessarily identical. In light of a stable performance with an enough margin, the height

H10*a* or H10*b* is preferred to be five times larger than the thickness T1 of the fuser belt 510 and to be 20% or less than the distance W1 (shown in FIG. 6). Also, the heights H11 and H12 are preferably, respectively larger than the heights H10*a* and H10*b*, and ideally at least twice as large as the heights H10*a* and H10*b*.

Upstream edge L81 of plane 537*a* is located at an upstream side from a tangent line L82 that is generated from the most upstream point of the roller 513. The distance E1 between the edge L81 and the tangent line L82 is preferably greater than the height H10*a*. In the embodiment, since the sizes of the rollers 513 and 523 are the same, the tangent line L82 of the roller 513 is the same as that of the roller 523. When the sizes of the rollers 513 and 523 are not the same, a tangent line that is generated from a lager roller is located at an upstream side than the other tangent line that is from a smaller roller. The tangent lines E1 are preferably larger than corresponding heights H10*a* and H10*b*.

Downstream edge L91 of plane 537*a* is located at a downstream side from a tangent line L92 that is generated from the most downstream point of the rollers 511. The distance E2 between the edge L91 and the tangent line L92 is preferably greater than the height H10*a*. In the embodiment, since the sizes of the rollers 511 and 521 are the same, the tangent line L92 of the roller 511 is the same as that of the roller 521. When the sizes of the rollers 511 and 521 are not the same, a tangent line that is generated from a lager roller is located at a downstream side than the other tangent line that is from a smaller roller. The tangent lines E1 are preferably larger than corresponding heights H10*a* and H10*b*.

In the embodiment, considering the size differences between the rollers (511, 521) and the rollers (513, 523), the distance E1 is 4.7 mm, the distance E2 is 5.6 mm which is larger than the distance E1. Considering features of the belts (510, 520), the distance E2 may be larger or smaller than the distance E1 regardless of sizes of the rollers.

With the structure, the fuser belt 510 is securely driven in the nip area W4 between the belt guides 537R and 537L because undesirable movement of the fuser belt 510 (or skewed or twisted in the Y direction which is a front to back side direction of the drawing sheet) is restricted by the planes 537*a* of the belt guides 537R and 537L. In a similar manner, the pressure application belt 520 is also regulated in the Y direction while being driven.

With the gap W6, even when the belts are skewed in the Y-direction or when the environmental temperature changes, the contact period for which the belts (510, 520) contact the belt guides (537R, 537L) is minimized so that the carrying load on the belts maintains low.

As discussed, the fuser belt 510 is driven in the tension free state. Due to lack of tensions in the X direction, the belt 510 is occasionally skewed in the X or Z direction so that the belt 510 contact any parts (537*b* to 537*e*) other than an upper half of the plane 537*a*, which is indicated with H10*a*. In such a case, the slopes (537*b* to 537*e*) guide the belt 510 to the upper half of the plane 537*a* so that the carrying load on the belt 510 maintains low. Similarly, the carrying load on the belt 520 also maintains low by the gap W6 or the slopes (537*b* to 537*e*).

These scales discussed in the first embodiments may be applied to the following embodiment(s).

Second Embodiment

FIG. 16 is an inside configuration view of the fuser unit 600 in the second embodiment based on the present invention viewed from the direction corresponding to the cross section A-A in FIG. 2 as being similar to FIG. 5 in the first embodiment. However, here, the bracket 530L, the pressure application roller lever 531L, and the like are omitted. FIG. 17 is a side view of the fuser unit illustrated in FIG. 16 viewed from the direction of the arrow F.

The point that the image forming apparatus that adopts this fuser unit 600 is mainly different from the image forming apparatus that adopts the fuser unit 500 in the first embodiment illustrated in FIG. 2. Described above is the point that the auxiliary roller 514 and the auxiliary pressure application roller 524 that make a pair (FIG. 5) are omitted and instead, the caster 638 is added on the belt guide 537L. Therefore, in the image forming apparatus that adopts this fuser unit 600, the parts that are in common with the image forming apparatus 1000 in the first embodiment (FIG. 1) are written with the same letters or the explanation is omitted by omitting the figures, and the points that are different are intensively explained. In the second embodiment, the main configuration of the image forming apparatus has the common configuration of the image forming apparatus 1000 in the first embodiment illustrated in FIG. 1 except the fuser unit 600, so the FIG. 1 is referred when it is needed.

FIGS. 18A-18C are configuration views illustrating the form of the belt guide 637L in FIG. 16. FIG. 18A is the front view, FIG. 18B is the right side view, and FIG. 18C is the top view. FIG. 19 is an appearance perspective view of the belt guide 637L in FIG. 16.

On this belt guide 637L, as being similar to the belt guide 537L explained in the first embodiment described above, the plane 537*a*, the slope 537*b*-537*e*, and the longhole 541-534 are formed. Then, along the plane 537*a* that locates between the longholes 541 and 542 that face each other and the long hole 534, the aperture 640 that is slightly wider than this plane 537*a* is formed. In the aperture 640, the roller 638 that has the rotation shaft in the width direction of the plane 537*a* (the direction perpendicular to the carrying surface of the record sheet) and that is rotatably maintained at the back of the aperture 640 by the belt guide 637L is arranged as illustrated in FIG. 18C so that a part of the peripheral surface of the caster 638 slightly protrudes from the plane 537*a*. The width of this caster 638 is set to be slightly narrower than the width of the plane 537*a*.

When this belt guide 637L is positioned on the bracket 537L (FIG. 5) by the screw 518 (FIG. 5), each slope 537*b*, 537*c*, 537*d*, and 537*e* has same characteristics that are similar to the belt guide 537L described in the first embodiment.

Further, here, as illustrated in FIG. 16, the nip area 529 is positioned at the approximately center part of the width of the caster 638. The side edge of the fuser belt 510 or/and the pressure application belt 520 at the nip area 529 moves and contacts the peripheral surface of the caster 638, so the caster 638 is configured so as to rotate. Here, the configuration and the installation of the belt guide 637L are explained. However, as being similar to the first embodiment, the belt guide 637R (not illustrated) that is configured to be the plane symmetry with respect to the virtual plane that perpendicularly crosses at the center of the drive roller 511 and the fuser unit 600 is similarly installed to have a similar configuration.

In the configuration above, the movement of the fuser unit 600 in the embodiment is explained.

Accompanied by the print start in the image forming apparatus, when the drive roller 511 rotates in the arrow C direction (FIG. 16) accepting the rotator power from the drive motor (not illustrated), accompanied by this, the fuser belt 510 and the pressure application belt 520 respectively rotate in the arrow D direction and the arrow E direction illustrated in FIG. 16. At this time, the fuser belt 510 or/and the pressure application belt **520** respectively start to move so as to balance themselves following the pressure generated by the drive roller **511** and the pressure application roller **521** that make a pair.

Namely, when the belt that starts traveling/rotating, each side edge of the belt contacts casters **638** that are disposed on the belt guides **637**L and **637**R. While the belts moves from side to side, the end parts of the belt are gradually lined up and become the state where they are properly aligned. That is, the drive roller **511** and the pressure application roller **521** are aligned, and also, the end part of them moves such that the side edge is lightly touched or not touched on the caster **638** that is disposed on the belt guide **537**L and the belt guide **537**R. Once the alignment is sent properly. The state is maintained.

In the embodiment, as the example, one caster **638** corresponding to an end part of the belt in the nip area is arranged. However, the present invention is not limited to this. For example, as illustrated in FIG. **20** and FIG. **21**, along the nip area **529**, a plurality of the casters **738** (here two) may be arranged.

FIGS. **22**A-**22**C are configuration views illustrating the form of the belt guide **737**L in FIG. **20**. FIG. **22**A is the front view, FIG. **22**B is the left side view, and FIG. **22**C is the top view. FIG. **23** is an appearance perspective view of the belt guide **737**L in FIG. **20**.

On this belt guide **737**L, the plane **537***a*, the slopes **537***b*-**537***e*, and the longholes **541**-**543** are formed as being same as the belt guide **537**L (FIG. **10**) explained in the first embodiment described above. Then, along the plane **537***a* that locates between the longholes **541** and **542** that face each other, the aperture **640** that is lightly wider than this plane **537***a* is formed. In this aperture **640**, two rollers **738** that have the rotation shafts in the width direction of the plane **537***a* (the direction perpendicular to the carrying direction of the record sheet) and that are rotatably maintained at the back of the aperture **640** by the belt guide **737**L are arranged side by side in the carrying direction of the record sheet so that a part of the peripheral surface of the caster **738** slightly protrudes from the plane **537***a*. The width of this caster **738** is set to be slightly narrower than the width of the plane **537***a*.

As described above, according to the fuser unit of the embodiment, at the nip area **529**, the fuser belt **510** and the pressure application belt **520** are guided by the caster **638** (**738**) and the side edge of each belt is lined up, and also, each belt is prevented from contacting the guide member except at the nip area. Therefore, the fuser belt **510** and the pressure application belt **520** that form the nip area in the tension free state are properly rotated, and also, the part of the belt side edge that is freely and unstably rotating does not accept a disturbance from the outside, so it is possible to prevent the twist or waving of the belt and the damage of the belt.

Further, according to the fuser unit of the embodiment, by the caster **638** (**738**), the side edge of each belt is guided while controlling the generation of the friction, so the damage to the belt is reduced and the belt life span becomes longer, and it is possible for the belt carrying to be stabilized for a long time.

INDUSTRIAL USABILITY

In the embodiment described above, the fuser unit of the color electrographic printer is explained as the example for the present invention. However, it can be used for the fuser device of the image forming apparatus that can copy color, single color, or monochrome, such as a copy machine, a facsimile, a printer, a multifunction machine.

What is claimed is:

1. A fuser device for fusing a developer image on a medium by applying heat and pressure, comprising:
- a belt part that has an endless shape and that is configured to rotate in a tension free state to carry the medium in a medium carrying direction;
- a first nip forming part that is arranged inside the belt part;
- a second nip forming part that is arranged to face the first nip forming part, and configured to apply a pressure toward the first nip forming part, sandwiching the belt part with the first nip forming part so that a nip area is formed therebetween, the developer image on the medium being fused during passing the nip area; and
- a regulation member that regulates a movement of the belt part in a width direction of the belt part, wherein
- the regulation member is configured with a belt regulation part and a slant part,
  - the belt regulation part has a flat shape that is arranged near one of side edges of the belt part along the nip area with a predetermined gap (W**6**) in the width direction of the belt part,
  - the slant part extends from an edge of the belt regulation part,
- the first nip forming part is a first roller that drives the belt part,
- the second nip forming part is a second roller that applies a pressure toward the first roller,
- the belt part is configured with a first belt part and a second belt part each of which has an endless shape,
  - the first belt part has the first roller arranged therein,
  - the second belt part, in which the second roller is arranged, is sandwiched between the first belt part and the second roller so that the medium is carried therebetween,
- further comprising:
  - a third roller that is arranged inside the first belt part and at the upstream side from the first roller,
  - a fourth roller that is arranged inside the second belt part and to face the third roller sandwiching the first belt part and the second belt part, and
- the nip area is formed in a region defined by a pair of the first and second rollers and another pair of the third and fourth rollers in the medium carrying direction.

2. The fuser device according to claim **1**, further comprising:
- another regulation member that is identical to the regulation member, wherein
- the another regulation member is arranged near the other of side edges of the belt part along the nip area with the predetermined gap (W**6**).

3. The fuser device according to claim **1**, wherein,
- the belt regulation part is positioned between a center of the first roller and a center of the second roller in a direction perpendicular to the medium carrying direction and the width direction of the belt part.

4. The fuser device according to claim **1**, wherein
- the slant part is a slope that extends from an upstream edge of the belt regulation part toward an upstream side in the medium carrying direction,
- the slope is inclined such that it separates farther from the side edge of the belt part in the width direction of the belt part as the slope goes toward the upstream side of the medium carrying direction.

5. The fuser device according to claim **1**, wherein the slant part is a slope that extends from a downstream edge of the belt regulation part toward a downstream side in the medium carrying direction,

the slope is inclined such that it separates farther from the side edge of the belt part in the width direction of the belt part as the slope goes toward the downstream side of the medium carrying direction.

6. The fuser device according to claim **1**, wherein the slant part is a slope that extends from a side edge of the belt regulation part at the first nip forming part side in a direction perpendicular to a surface of the belt part,

the slope is inclined such that it separates farther from the side edge of the belt part in the width direction of the belt part as the slope goes farther from the nip area.

7. The fuser device according to claim **1**, wherein the slant part is a slope that extends from a side edge of the belt regulation part at the second nip forming part side in a direction perpendicular to a surface of the belt part,

the slope is inclined such that it separates farther from the side edge of the belt part in the width direction of the belt part as the slope goes farther from the nip area.

8. The fuser device according to claim **1**, further comprising:

a fifth roller that is arranged inside the first belt part and between the first roller and the third roller, and

a sixth roller that is arranged inside the second belt part and between the second roller and the forth roller to face the fifth roller sandwiching the first and second belt parts with the fifth roller.

9. The fuser device according to claim **1**, wherein the belt regulation part has a length longer than a length of the nip area in the medium carrying direction, and

an upstream edge of the belt regulation part is at a farther upstream side than the nip area,

a downstream edge of the belt regulation part is at a farther downstream side than the nip area.

10. The fuser device according to claim **1**, wherein the second belt part is configured to travel in a tension free state.

11. The fuser device according to claim **1**, further comprising:

a caster that is arranged in the belt regulation part, of which a rotational shaft being oriented in a direction perpendicular to a surface of the belt part, and of which a perimeter rotates around the shaft, wherein

the caster is projected toward the nip area from the belt regulation part in order to slightly contact the side edge of the belt part.

12. An image forming apparatus, comprising:

a medium feeding part that feeds a medium;

an image forming part that creates a developer image on the medium; and

the fuser device according to claim **1** that fuses the developer image on the medium.

13. A fuser device for fusing a developer image on a medium by applying heat and pressure, comprising:

a belt part that has an endless shape and that is configured to rotate in a tension free state to carry the medium in a medium carrying direction;

a first nip forming part that is arranged inside the belt part;

a second nip forming part that is arranged outside the belt part to face the first nip forming part, and configured to apply a pressure toward the first nip forming part, sandwiching the belt part with the first nip forming part so that a nip area is formed therebetween, the developer image on the medium being fused during passing the nip area; and

a regulation member that regulates a movement of the belt part in a width direction of the belt part, wherein

the regulation member is configured with a belt regulation part and a slant part,

the belt regulation part has a flat shape that is arranged near one of side edges of the belt part along the nip area with a predetermined gap (W**6**) in the width direction of the belt part,

the slant part that is inclined with respect to the flat shape of the belt regulation part, is connected to an edge of the belt regulation part, and is positioned outside the belt part in the width direction of the belt part.

14. The fuser device according to claim **13**, wherein the slant part is a slope that extends from an upstream edge of the belt regulation part toward an upstream side in the medium carrying direction,

the slope is inclined such that it separates farther from the side edge of the belt part in the width direction of the belt part as the slope goes toward the upstream side of the medium carrying direction.

15. The fuser device according to claim **13**, wherein the slant part is a slope that extends from a downstream edge of the belt regulation part toward a downstream side in the medium carrying direction,

the slope is inclined such that it separates farther from the side edge of the belt part in the width direction of the belt part as the slope goes toward the downstream side of the medium carrying direction.

16. The fuser device according to claim **13**, wherein the slant part is a slope that extends from a side edge of the belt regulation part at the first nip forming part side in a direction perpendicular to a surface of the belt part,

the slope is inclined such that it separates farther from the side edge of the belt part in the width direction of the belt part as the slope goes farther from the nip area.

17. The fuser device according to claim **13**, wherein the slant part is a slope that extends from a side edge of the belt regulation part at the second nip forming part side in a direction perpendicular to a surface of the belt part,

the slope is inclined such that it separates farther from the side edge of the belt part in the width direction of the belt part as the slope goes farther from the nip area.

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